LOCATIONAL ANALYSIS OF CROP LANDUSE IN GURGAON DISTRICT

THESIS SUBMITTED FOR THE DEGREE
OF
DOCTOR OF PHILOSOPHY
IN
GEOGRAPHY

UNDER THE SUPERVISION OF

PROF. MOHAMMAD SHAFI
Professor Emeritus
DEPARTMENT OF GEOGRAPHY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

BY

MOHD. MAZHAR ALI KHAN

DEPRATMENT OF GEOGRAPHY
ALIGARH MUSLIM UNIVERSITY
ALIGARH
1998

LOCATIONAL ANALYSIS OF CROP LANDUSE IN GURGAON DISTRICT

THESIS SUBMITTED FOR THE DEGREE
OF
DOCTOR OF PHILOSOPHY
IN
GEOGRAPHY

UNDER THE SUPERVISION OF

PROF. MOHAMMAD SHAFI
Professor Emeritus
DEPARTMENT OF GEOGRAPHY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

BY

MOHD. MAZHAR ALI KHAN

DEPRATMENT OF GEOGRAPHY
ALIGARH MUSLIM UNIVERSITY
ALIGARH
1998

ABSTRACT

The district of Gurgaon, a part of Southern Haryana Plain, is named after its city headquarter, Gurgaon. With a geographical area of 2675.0021 square kilometers (259.37 thousand hectares), it extends between the geographical co-ordinates of 27° 39' 40" N to 28° 31' 05" N and 76° 39' 40" E to 77° 20' 15" E.

AIMS AND OBJECTIVES

The aims and objectives of the present study are to test the following hypotheses both at macro-level i.e., regional scale and at micro-level i.e., village scale.

Hypotheses for Macro-Level Study

1. With increasing distance from the urban settlements (market centre), the intensity of cropping decreases. This hypothesis is tested because according to Von Thunen, the intensity of cropping decreases towards the margin of cultivation. It also seems to decline with distance from railways and highways, because as perceived by the researcher, the application of the doses of inputs is also affected with increasing distance/decreasing accessibility from the lines of communication.

2. With increasing distance from the canal i.e., decreasing intensity of canal irrigation, the intensity of cropping decreases. Since in semi-

arid climate of the region water is the main input to agriculture, canal irrigation brings about perceptible changes in the intensity of cropping.

3. With increasing intensity of tube-well irrigation, the intensity of cropping increases for the reasons mentioned above.

4. The locational distribution of cereals, pulses and oil seeds will increase or in other words, the intensity of cereals, pulses, and oil seeds cultivation will decrease with increasing distance from the urban settlements while that of vegetables and fodder will decrease at macro-level. According to Von Thunen those crops which are less intensive like cereals find more favourable locations at some distance away from the settlement while crops like vegetables which are in much demand in cities and are perishable, occupy a location near the market-places. Fodder show a declining locational trend away from the cities because of its low-value and bulky nature.

5. Following the same reasoning mentioned above, the locational distribution of cereals, pulses and oil seeds will increase while that of vegetables and fodder will decrease with increasing distance from railways and highways, since accessibility decreases with increasing distance from them.

6. With increasing distance from the canal or decreasing intensity of canal irrigation, the locational distribution of cereals (Kharif), pulses, fodder and oil seeds will increase, as these crops require comparatively less amount of water. While the area under cereals (Rabi) and vegetables will decrease, because they require much water for being grown.

7. In angular zoning with increasing intensity of tube-well irrigation the locational distribution of cereals (Kharif), fodder, pulses and oil seeds decreases since these crops require less amount of water, while that of cereals (Rabi) and vegetables will increase.

Hypotheses for Micro-level study

8. With increasing distance from the village settlement, the intensity of cropping decreases. This hypothesis is formulated for being tested, because soil fertility and the level of inputs decline gradually with distance from the village settlement.

9. The locational distribution of Kharif cereals, pulses, fodder and oil seeds will increase with increasing distance from the village settlement, because these crops need less amount of water for their cultivation. The fodder crops are of low-value and high-bulk in nature and their cultivation is extensive, moreover, the distances involved at village scale are comparatively smaller.

10. With distance from the village settlement the locational distribution of Rabi cereals specially wheat will increase particularly in villages with assured irrigation facilities, because high yielding varieties of wheat, the dominant Rabi cereal require several waters during its field life.

11. The locational distribution of vegetables will decrease with increasing distance from the village settlement. The reason for this type of pattern is that vegetable fields need much attention and field visits of the cultivators for the purpose of protection from stray animals.

METHODOLOGY

Data Generation at Macro-level

The present study is planned on two levels. A macro-level approach deals with circular zoning around urban settlements, oblonged zoning along railway, parallel zoning along highway and canal as well as angular zoning around the urban settlements. In each case of zoning, six zones each of two kilometers width were drawn from the point of origin up to a distance of twelve kilometers.

As far as the sampling of the villages is concerned, for each category of zonation and for each zone in every category, a stratified random sampling was carried out keeping the size of the sample to 20%

for each zone separately. In this way 92 villages out of 451 were picked up for the present study on macro-level (Fig. 1.0, Appendix-I). The crops data collected for each village were clubbed together in several categories of crop groups like cereals, vegetables, oil seeds, pulses, and fodder separately for both Kharif and Rabi cropping seasons (Appendix-II).

For all the villages, lying in each zone, the corresponding acreage values of various crops/crop groups and other categories like net sown area and double cropped area, both for Rabi and Kharif cropping seasons were added up separately and their percentages were calculated by taking net sown area in the denominator.

'Statistical treatment of data was done using simple bivariate correlation and regression analyses. Student's t-test was applied on regression coefficients to test the formulated hypotheses. For this purpose, independent variables selected were (a) the average distance of each zone from its point of origin i.e., 1, 3, 5, 7, 9, and 11 kilometers (b) zone-wise intensity of irrigation in case of angular zoning about Sohna and Nagina. The rest of the variables were dependent variables like, double cropped area, and the various categories of crops/crop groups. For each pair of variables, a scatter plot along with least square line was plotted in order to study the trend and strength of relationship.

In corresponding zones of each zoning schemes, the percentages of the locational distribution of crops and intensity of various crops/crop groups both for Rabi and Kharif cropping seasons were calculated with respect to net area sown, and were plotted in the form of line graphs.

These line graphs were presenting the percentage of crop groups along the ordinate and distances from the settlements/railway/highway/canal along the abscissa. In case of angular zoning around Sohna and Nagina, since number of tube-wells were of less significance as compared to intensity of tube-well irrigation, hence, intensity of tube-well irrigation was selected as independent variable and plotted along abscissa for the purpose of research. Scatter plots with least square line as well as statistics about correlation, regression and student's t-test were also worked out in order to help interpretation of the results with some level of confidence.

Data generation at micro-level

The second part of the study is based on micro-level investigation, which is related to the study of individual villages. In order to satisfy each of the following criteria, a representative village was selected through purposive sampling.

1. Less than 2 kilometers from a small town and far away (more than 2 kilometers) from railway, road, and canal and having a great dependency upon rainfall for agriculture, so that the influence of a small town on the crops could be assessed.

2. The location of crops under tube-well irrigation and far away (more than 2 kilometers) from any of the city, road, railway and canal was examined, so that the sole influence of tube-well irrigation could be assessed.

3. With maximum dependency on rainfall for cropping, and far away

(more than 2 kilometers) from any of the city, road, railway and canal, so that the locational patterns of crops in a rain-fed agriculture system could be studied.

4. At a distance of less than 2 kilometers from a road/railway-the transportation artery and far away (more than 2 kilometers) from city and canal within rain-fed agriculture system. so that the influence of road/railway (i.e., accessibility) on the location of crops could be assessed.

5. Less than 2 kilometers from canal with maximum area under canal irrigation, and far away (more than 2 kilometers) from city, road, railway, so that the influence of canal/canal irrigation on the location of crops could be assessed.

6. Less than 2 kilometers from a big city, and road together with maximum area put to tube-well irrigation, and far away (more than 2 kilometers) from canal, so that the combined influence of big cities, easy accessibility, tube-well and irrigation on the location of crops could be assessed.

Taking the core of the village settlement as the centre of the village, the land surrounding the village settlement was demarcated into six concentric rings of almost equal width. The total area lying under each zone was computed by using square method with the help of a graph paper. The area put under various Rabi and Kharif crop groups like cereals, vegetables, fodder crops, oil seeds, and pulses, as well as double cropping were computed for each zone and the percentages were calculated. Proper cartographic representation of these individual villages using maps, poly-graphs and scatter plots is also taken up.

ORGANISATION OF THE WORK

The study is initially aimed at identifying the impact of distance and intensity of irrigation in determining cropping patterns and cropping intensity. Therefore, the whole study is designed in such a way as to cover not only the central theme but also the fringing aspects influencing the outcome of the study.

Since the agricultural landuse patterns and location of crops is an outcome of interaction between various natural and cutlural factors therefore, Chapter-I deals with the environmental framework of the study area. It deals with the general physical back ground, human resource base, irrigation systems, and agricultural profile of the Gurgaon district. Chapter-II takes a review of the factors which affect the location of crops in agricultural scenario specially in an Indian economy. Since the concept of rent and economic rent was the main driving force behind the evolution of the Thunen's model of agricultural location, hence, in order to have a good comprehension of the Thunen's model, a descriptive account about the concept of rent and economic rent is attempted in the form of Chapter-III. The applicability of Thunen's model requires an understanding of the model itself. However, the conditions thought to be conducive for the evolution of the basic assumptions are changing fast in a changing world. Therefore, Chapter-

IV deals with the crop location theory of Von Thunen at length focussing upon a critical evaluation of Thunen's hypothesis. Under varied physical, social-economic conditions, Von Thunen's model has been applied for being tested in different parts of India by several scholars. Therefore, a critical appraisal of the work done is attempted in Chapter-V. It provides a base to carry over the present study to further testing of hypotheses in the study area. In order to identify the patterns of cropping intensity and the location of crops with respect to various factors of location, two approaches are followed. chapter-VI is devoted to study the location of crops and cropping intensity at macro-leverl or regional scale, about the urban settlements and linear features like roads, railways and canals. Chapter-VII tries to bring about the variations in the location of crops and cropping intensity at micro-level that is at village scale. Six villages have been selected after purposive sampling so that each of the village is satisfying a certain criterian laid down for the purpose of hypothesis testing.

The entire study is, therefore, contained in seven chapters which are followed by conclusion and suggestions.

FINDINGS AND SUGGESTIONS

The study made by Von Thunen in 'Isolated State' was economic translation of cropping patterns, in terms of their location with respect to increasing distance from a market place, subject to given laboratory conditions. Complications are introduced when agriculture is considered as a dynamic process. Although, aspects of physical environment are taken as stable over considerable period of time, the economic environment is very unstable. Changes in demand, supply and price structure, and government assistance are of considerable significance which bring about changes in cropping patterns and their locations. The outcome of this study is expressed in following lines.

Intensity of cropping

At macro-level the intensity of cropping increases with increasing irrigation intensity. However, from urban centre if irrigation facilities are available it increases with distance. It decreases with distance away from canal. The Patakpur Mionr Canal is not a perennial canal and for most parts in Rabi seasons it remains dry. The irrigation is carried on by tube-wells which are private in general. Canal for irrigation purpose is therefore, ineffective in the Rabi seasons. Among the lines of communication, the gradient of cropping intensity is steeper for railways than roads. At micro-level (village level), the intensity of cropping generally decreases outwards from the village habitat, irrespective of whether the village has a rainfed, or an irrigation propelled agriculture, or the village is situated in immediate neighbourhood of an urban centre (big/small), a road or a canal.

Cereals

At macro-level, Kharif cereals, wich are less water demanding crops, and generally depend on rainfall the rising trend of their distribution is due to real extensification in respect of increasing distance from urban centres and the lines of communication. The distribution of Rabi cereals among which wheat dominates, its distribution is affected primarily by irrigation availability, and secondly, by the factor of demand which is generated by the volume of population of the neighbouring cities. At micro-level, in rainfed villages, the locational distribution of both Kharif and Rabi cereals decreases with distance from the village settlement while reverse is true for those villages which are having good irrigation facilities.

Vegetables

At macro-level vegetables, which require frequent visits of the farmers for the sake of protection from stray animals, and are perishable products, Therefore, vegetables require a ready market, and their locational distribution in both Kharif and Rabi seasons follows Von Thunen's proposition partially and declines with increasing distance not only from the market places. Moreover, with respect to the lines of communication, canal, and decreasing tube-well irrigation facilities. At micro-level as well, the same is true.

Oil Seeds

At macro-level the locational distribution of oil seed crops distribution in both Kharif and Rabi cropping seasons, in general show a mild increasing tendency with distance from the urban centres as well as with increasing tube-well irrigation facilities. The lines of communication and distance from the canal has no bearing on the extensification of these crops. At micro-level in study area, in rainfed agricultural system with distance from the village settlement, acreage under Rabi oil seeds decreases. In villages with good irrigation facilities, Kharif oil seeds do not seem depending much upon irrigation which is evident from their fluctuating trend of distribution. The Rabi oil seeds, however, show a positive tendency of distribution, that is, area under oil seed crops increases with distance. It is in fact not out of extensive agriculture, but due to putting large area under oil seeds and is rather a case of commercial farming of these crops.

Fodder

Locational distribution and concentration of fodder crops indirectly indicates about the developmental state of dairy farming. Fodder at macro-level in general, it is established that locational distributional of fodder crops both in Kharif and Rabi seasons decreases with distance from urban centers and the lines of communication. However, with respect to distance from canal and tube-well irrigation the trend is seen opposite to that postulated i.e. with increasing distance from the canal a tendency of decrease (Rabi season) and with increasing intensity of tube-well irrigation a general miled increase establishes that fodder cultivation and its locationl distribution in the study area with semi-arid climate, is to some extent dependent upon water supply. At micro-level in both Kharif and Rabi cropping seasons, in both rainfed as well as irrigated environment, with respect to increasing distance from the village habitat, the declining tendency of fodder distribution is established.

Pulses

At macro-level, it is establishd that gnerally a declining locational trend of pulses is established with respect to distances from urban centres. The factor of eccessibility i.e. nearness to a line of communication, apparently has no bearing on the location of pulses. However, provision of better irrigation facilities seems to have a positive bearing on the locational distribution of pulses. In rest of the cases, the locational distribution of pulses is found opposite to the respective propositions. The apparent low level extensification of pulses around Gurgaon (Rabi season) and in angular zones about Sohna, is towards intensive commercial farming of pulses under the pressure of demand generated by Delhi Gurgaon and Sohna cities. At micro-level in a system of rainfed agriculture, the distribution of pulses generally show a decreasing trend, while in an atmosphere of good irrigation (tube-well or canal) an extension in the farming of pulses is found.

Keeping the above facts on record, it is put forward that, the model of Von Thunen in the present day world along with its many complexities, for the district of Gurgaon is not acceptable in toto. However, it is applicable only to cropping inensity, and vegetables distribution. The location of fodder crops, which sets a defenet decreasing trend away from the urban settlements and the lines of communication, resembles the case of low value and high bulk product which according to Von Thunen fined a location more comfortable, if ease of transportation is there. In other cases the hypotheses do not hold good.

In fact, the impact of other factors on the location of crops, should also not be underestimated. These factors which are relief variations, soil types, technological developments and cultural patterns, as well as, subjective crop preferences of different ethnic rural communities that modify cropping patterns in the study area append more significance to them. In order to improve agriculture in the study area following suggestions are put forward.

Semi-arid conditions and limited sub-soil water makes it significant to promote scientific management of ground water through sprinkler and drip irrigation systems. This will help arresting wasteful losses of water through evaporation on one hand and would slow down the over exploitation of fresh sub-soil water on the other. Consequently, a check will be applied on the recession of water table. A micro-level i.e., village level study of aquifers and quality of ground water is necessary for the assessment of the potential of ground water resources. Efforts should be made in order to ascertain a regular flow of water in Gurgaon Canal on one hand as well as to increase its command area by extending the length of its distributaries particularly in areas where sub-soil water is saline.

Gurgaon is a major city of the area, both Gurgaon and smaller cities with their adjoining areas are influenced by Delhi in respect of the marketability of agricultural produce. Thunen's dictum stands modified in respect of cereals particularly wheat and the modified assertion is that wheat being a Rabi crop, requires several waterings and its locational pattern is not dependent on distance from the market, but from the source of irrigation. Therefore, above mentioned efforts should be made to increase the irrigated area and to promote water management practices. This will lead to increase production and with the government procurement policy, which are yet to be made further effective, the farmers can sell their produce to the procurement centres and keep the remaining cereals for their family's needs.

In respect of vegetables Thunen's dictum holds good, however, there is a need to further improve the transport system both in respect of the towns of the district and towords Delhi..

LOCATIONAL ANALYSIS OF CROP LANDUSE IN GURGAON DISTRICT

THESIS SUBMITTED FOR THE DEGREE
OF
DOCTOR OF PHILOSOPHY
IN
GEOGRAPHY

UNDER THE SUPERVISION OF

PROF. MOHAMMAD SHAFI
Professor Emeritus
DEPARTMENT OF GEOGRAPHY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

BY

MOHD. MAZHAR ALI KHAN

DEPRATMENT OF GEOGRAPHY
ALIGARH MUSLIM UNIVERSITY
ALIGARH
1998

Prof. Mohammad Shafi

PROFESSOR EMERITUS – Ex PRO-CHANCELLOR

Phones { Office (0571) 400683
Res. : (0571) 400320

DEPARTMENT OF GEOGRAPHY
ALIGARH MUSLIM UNIVERSITY
ALIGARH–202 002

Dated : ....

CERTIFICATE

This is to certify that the present thesis entitled "Locational Analysis of Crop Landuse in Gurgaon District" submitted by Mr. Mohd. Mazhar Ali Khan is an original piece of ivestigation and record of research carried out by him under my supervision.

I find the thesis fit for evaluation.

(PROF. MOHAMMAD SHAFI)

ACKNOWLEDGEMENTS

I wish to express my deep sense of gratitude to Professor Mohammad Shafi, Professor Emeritus, Department of Geography, Aligarh Muslim University, Aligarh for his valuable guidance and supervision, which was indespensible for the completion of this work. I am also thankful to all of my teachers, particularly Professor Abdul Aziz, Professor Mehdi Raza and Professor Mohammad Farooq Siddiqui of the same department for their encouragements which they extended to me from time to time. I am also indebted to Professor Abha Laxmi Singh and Professor Ali Mohammed (Chairperson) for their valuable help and active cooperation. Sincere thanks are also due to Mr. Khwaja Mubeen Ahmad, Mr. Tariq Asad and other members of the administrative staff who extended every possible secretarial help without any hesitation.

It would not be out of place to mention my deep sense of gratitude to Lt. Gen. Mohammad Zaki, Shaikhul Jamia (Vice Chancellor), Jamia Millia Islamia, New Delhi for his encouragements which enabled me to complete this piece of work.

Deep regards are due to late Professor Qazi Mohammad Ahmed, the architect of the Department of Geography, Jamia Millia Islamia, New Delhi, for his sincere advice and good wishes which he extended to me from time to time. I express my deep sense of gratitude to Dr. Mohammad. Firoz Khan (Reader), a scholar of Geography, Jamia Millia Islamia.for his scholarly suggestions and encouragements. Thanks are also due to Professor S.M. Rashid, Dr. Mohd. Ishtiaq (Reader), Dr. Masood Ahsan and Dr. Mohd. Zulfequar Ahmad Khan from the same department for their help which they extended to me.

I am also thankful to Mr. Yasin Khan, senior cartographer in the department, who happens to be a member of the community of Meos, and is a native of the same part of Mewat which is lying in the study area, about which he has provided many valuable informations in several ways.

It would be a great lapse on my part if I do not mention the names of my students, Mr. Narainder Kumar Saini, Mr. Sandeep Bhatnagar and Mr. Bikram Kumar Datta, who are now spearheading the field of cartography professionally. My students spared their valuable time and extended their generous help as far as cartographic work is concerned.

I am also thankful to my friends from Jamia Millia Islamia, specially Dr. Mushahid Hussain (Reader), Department of Physics; Dr. Anwar Ali (Reader), Department of Chemistry; Dr. Zeeshan Hussain Khan, Lecturer Engineering College, who extended their computer lab facilities and spared their precious time in compuations and analyses of data at various stages.

The name of Mr. Tausifuddin, is signficant to me for he devoted his lot of precious time in getting this draft of the thesis typed.

I am also highly thankful to my wife Ms. Shahnaz Parveen, a senior faculty member in the department for her moral support and sustained interest in my research work.

I would not hesitate to extend my deepest gratitude to my parents, who always extended all assistance and encouragement towards the completion of this piece of work.

(MOHD. MAZHAR ALI KHAN)

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

INTRODUCTION

The micro-economic neo-classical approach is directed towards the model building in geography of economic production around the city. It is represented in the form of a coherent theory in which the concept of surrounding urban location of economic activites as a result of bidding process for land are being regulated by the market. This was an essential asumption of Von Thunen's model of agricultural location with respect to crop distribution. It was very strongly supplemented by empirical evidences. However, many of the background assumptions, a pre-requisite for 19th century Mecklenburg, seem to be out dated. The advent of cheap fuel and the scale of economies of ever-rising volumes of production in circulation have generally reduced the relative cost of transport resulting in reduction of over all cost of production. The perishable natutre of agricultural commodities, under primitive system of transportation, has limited the range of consumption which was mostly confined to the domestic market. However, under the influence of fast technological development, with the available refrigeration and food preservation facilities, the impact of transport and nearby local market is becoming less significant. The rapid changes in distance and movement relations, have resulted in curvi-linear relationship rather than linear. Further, the distance and intensity of cropping has become a stepped phenomenon rather than continuous one.

The Von Thunen's model of crop location and its corresponding zones are becoming more and more distorted due to a number of inter-acting factors. The basic assumptions of Thunen's hypothesis have been relaxed to accomodate the fast technological developments. Apart from the very intimate link between physical resources and agriculture, the substitution of the resource inputs affects the distance-decay model. The role of irrigation, in Indian context of crop location, can hardly be overlooked. Thus, intensification of cropping in the inner zones and extensification of cropping at outer zones may not fit in the present agricultural scenario in India. Although, 70% of its population is engaged in agricultural activities, the rapid encroachment of non-agricultural land uses near urban hinterland are transforming the basic patterns of location of crops specially around cities. Although, the widely spread sphere of influence of various co-operative schemes and government policies have provided a net-work of rural developmental programmes, yet, the area near and around the Indian cities seems to be more sensitive in recording the agricultural changes. These landuse patterns under growing pressure of population of both rural and urban areas, is influencing the margins of the cities. Rural-urban fringes, are recording the maximum impact of urbanization process due to which the cropping intensity is becoming more responsive to the demand of market and becoming more varied in nature. This phenomenan is further supplemented by the rationality of maximization of profits. However, in case of India, the subjectivity of farmers in his behavioural pattern decides the location and production of a particular crop which not always seems to satisfy the economic criteria. Gurgaon, lying within the ambit of Delhi National Capital Region, with fast developmental programmes introduced by foreigners and multinationals, has brought about an interesting agricultural scenario which certainly needs investigations in the light of the hypotheses formulated by Von Thunen.

STATEMENT OF THE PROBLEM

A systematic description of the location of economic activity at different distances in respect of a market place under the influence of variable economic rent was first of all envisaged by John Heinrich Von Thunen in 1826. His study was an empirical study which he carried out for the recognition of possible locations of various crops with increasing distance from the city of Rostok in Germany in the form of concentric rings. The very purpose of his study was to arrive at various combinations of the doses of inputs so that the margin of profit could be maximised. A simplified representation of the location of agricultural activities and cropping patterns was, thus, put forward in the form of a model. His model brought about a major shift in the techniques of agricultural landuse analysis specifically in case of land values and the intensity of farming in relation to increasing distance from the settlements.

Since, the process of agricultural development in India is basically a function of differential doses of inputs (labour, fertilizers, water, machinery etc.) interacting with environmental constrains of varying intensity under the inhibiting influences of institutional factors of different scales, where all the three operate together positively i.e. where institutions are less restrictive, environment more conducive and the doses of inputs high, it becomes possible to lessen the grip of inherited underdevelopment and a limited break-through is achieved in agriculture on regional scale. On the other hand, where the three work together negatively i.e., where the institutions are highly inhibitive, environment severe, and the level of inputs low, the regional agriculture becomes handicapped in moving beyond the stage of the sub-marginal subsistence. In case where the three operate in different directions or in the same direction with different degrees of intensity, agriculture on regional scale operates along at an unsatisfactory pace.

Urban centres, through the influencce of demands of various agricultural produce, provide economic environment conducive for agricultural production for special agricultural commodities in the near hinterlands. Communication arteries - roads and railways i.e., the system for the movement of inputs to the fields and agricultural produce to the market, provide an environment where accessibility from market to fields and vice versa is ascertained. Water being the most important input in agriculture exerts its influence in determining the intensity of cropping on one hand and the types of crops to be grown on the other.

The present study on "Locational Analysis of Crop Landuse in Gurgaon District", therefore, aims at finding out the existing cropping patterns and cropping intensity variations under the varied physical and socio-economic conditions of the study area on one hand and the responsible factors for the existing variations on the other. A detailed study of the locational patterns of crop cultivation and the intensity of agriculture in respect of increasing distance from the market-places, communication arteries, means of irrigation, has been attempted to provide a deep understanding of the existing agricultural mechanism in the study area. This in turn will help in understanding the trends of agricultural production in similar specific conditions in other parts of the country as well.

REVIEW OF LITERATURE

The model of agricultural location presented by John Heinrich Von Thunen in 1826 was the first attempt which effectively described the location of crops and the intensity of cropping in relation to distance from the market place in an Isolated State. According to him, economic rent derived from any particular agricultural landuse is a function of linear distance from the central market. Different landuses have different rent-distance relationships. The basic idea is that the form of agricultural landuse which produces the greatest rent will make the highest bid for the land and, thus, displaces all other landuses. That was the real mechanism of the development of agricultural landuse studied in concentric zones around a market place in contemporary world. Thunen's work has been greatly tested, assessed as well as critically evaluated on several grounds by a number of scholars in India and abroad.

A modest attempt to go through the contributions made by different scholars in this direction is made in the following pargraphs.

First, general theory of location with demand as the major spatial variable was produced by Losch, A. (1940). Its English translation appeared in 1954. In his theory Losch tries to show, that the pattern of location in given circumstances will meet certain conditions which define the state of equilibrium.

Losch attempts to find the maximum profit location for two products by comparing the cost of production, and the market area which could be controlled from alternative locations. He presented a more precise algebraic formulation to the principles of orientation, while following Von Thunen he considered economic rent as the determinant in production orientation and proceeded to see how different variables, production costs, production price and yield influence the spatial arrangement through their impact upon rent. According to him when two crops are raised, a condition is evolved under which crop-I would yield a greater rent at the centre and a lower rent at the periphery than crop-II.

Losch recorded that the cost fuel, services, wages and actual rent would be lower with the distance from the city. This was due to surplus of population and the lower density of population of rural areas. The availability of labour is a sgnificant factor in crop cultivation, and intensity of production. As far as the condition of transportation is concerned, it has lesser significance than labour costs. The development of greater intensity of production at more distant locations or inversion of Von Thunen's zonal rings (assuming machinery cannot normally increase the intensity of crop production in an area) are attributed towards the availability of labour.

Assuming a broad homogeneous plain with an even distribution of raw materials, uniform transport rates in all directions, evenly distributed agricultural production, identical tastes of all individuals like technical knowledge, and economic opportunities and evenly distributed self sufficient farmsteads, Losch tries to achieve equilibrium in the spatial arrangement of economic activities under the given set of conditions.

How equilibrium is reached may be described as if a single farmer decides to produce a surplus of beer for sale, then his sales area will be circular, bounded by a locus of point at which his price becomes too high to sell any beer at all. But if others enter the beer trade a competition will be held between them which gradually will reduce the size of the sales area until ultimately they become hexagonal in shape and all space is filled up.

Explaining the reasons for ring formation , Losch states that a necessary condition for it, is an inequality of yields, and the product with the largest yield would be produced nearest to the market. Losch derives a formula for the delineation of boundary between two crops. But he fails to take into account the influence of the transport rate variable.

From this exercise he concludes: first, it is established that the historic ring formation will occur in only ten out of twenty seven possible cases i.e., the arrangement of agricultural production is a special case. A second conclusion is that certain combinations of variables may result in mixed farming with different products in adjoining fields.

The most obvious weakness in the Losch's study is that he develops his whole elaborate scheme around two commodities. Certainly any realistic self-contained agricultural economy will be a multiple-product system.

Losch considers the influence of demand also, in his scheme. The possibility of an infinite range of prices as well as other variables not be ignored. If any crop is excluded from production, immediately a pressure is built up, which operats through demand, in order to increase the price and bring it within a range that would permit it to take its place in the rings of products.

It may, therefore, be concluded that multiple product farming system primarily forms the joint cost character of farm production, and the spatial discontinuities arise out of the spatial differentiation of resources and transport systems.

Chisholm, M. (1962) in his study on 'Rural Settlement and Landuse'found out that in various parts of the world, the Thunonian type of crop zonation was a common phenomenon around the market places. He states that in parts of Bulgaria, before the communist government came to power, the zoning of production around the villages was observed, where very close to the village some communal pasture lands, and wood lots were found and beyond which the specialised crops which require large amount of labour like vines, roses, and tobacco were cultivated. Next to these specialised crops, were the fields farmed in a two-year rotation supporting crops like wheat and maize. At the edge of the territory, there may be some pioneer vineyards or rose garden in the forest. The same phenomenon was also observed in Britrh Isles, in spite of the absence of large agro-towns.

Chisholm also came across similar situation in west Afica (Soba and Nigeria) where the spatial distribution of crops around a village in numerous cases was basically related to the distance from the village. Within the village walls, the dwelllings were intermingled with 'gardens' where vegetables were grown in great profusion and apparent confusion with close interplanting and careful catch cropping. Outside the walls, continuously cropped land extended to a distance of 0.8-1.2 kilometers, which was fertilised with manures and the droppings of the migrant cattle, and growing the staple crops of guinea corn, groundnuts, tobacco and cotton. Beyond this zone was lying another zone of 0.8-1.6 kilometer width which was under rotation farming, the land being cultivated for three to four years and then allowed to revert to bush for at least five years in order to restore the lost fertility which could otherwise entirely be destroyed in the absence of manures. Fourth comes the heavy bush in which there were small clearings around isolated settlements, then clearings reproducing the sequence described above. This general arrangement as observed by Chisholm arises on account of the problem of distance, though the quality of terrain modifies the theoritical summary.

An identical situation was found by Chisholm in Senegal where garden crops, maize, cotton,tobacco and groundnuts were found near at hand in a system of polycluster, and millet further away as extensive monoculture merges into the bush.

The students of Micheal Chisholm show concern upon the partial approach to the general problem of location of rural settlement and agricultural landuse through the analysis of the significance of the distance factor which affects the type of farming on each plot as well as its influence on the regional patterns of agriculture and indeed world distribution of crops and farming systems. In this analysis, Chisholm rightly draws heavily on the ideas of both Von Thunen and G.K.Zipf, and briefly refers to the work of German, French and American schools of location theorists.

In introducing his subject, Chisholm differentiates between the partial and general approches to the location problem, emphasizing the basic importance of understanding the landuse competition and allocation process, and chooses to examine those aspects that relate to the function of relative location.

While discussing about the arrangement of landuse systems, and the location of rural settlement, Chisholm follows Von Thunen and Weber. In this connection, he particularly pays his attention to the concept of economic rent and its relevance to an understanding of landuse competition processes.

In distinguishing the Thunen's "Isolated State" he is less concerned with its explanatory value than its use as a method of analysis and as a tool with which to examine the effects of other variables. Attention is focussed on the nature and implications, in terms of the simplifying assumptions on which the model is based.

Chisholm tries to relate the fact of theory, successively at the level of (i) the farm and the village, and (ii) the region and the world. In doing so, he proceeds first, from the assumption of a given location for the settlement, to consider the evidence for the operation of the distance factor in determining the arrangement of agricultural landuses around these settlements, in other words, the effect of distance factor on the movement of goods and persons through the transport charges, on smaller as well as larger scales and subsequently on the patterns of landuses. Later on, the location of the settlement is allowed to vary in relation to the influence of the natural conditions and desireable landuses. In further discussion, Chisholm is mainly concerned with the problem of location of lines of communication through the demonstration of the fact that such an artery in best located, where the actual or potential traffic is at its greatest.

In his concluding account, Chisholm discusses the technical changes and the important relationships between stage of economic development, technology and the functioning of the distance factor in the context of developed agricultural societies. The bearing of technology on the distance factor is discussed in terms of the effects, internal to the farm holding and external to the farmstead and other settlement forms, for example, the substitution of bicycles, motor-bikes and cars etc. for more primitive methods, resulted in a substantial decline in the relative cost of transport. Consequently, the rural workers may live several kilometers away from the working places in order to meet out their social and cultural needs, and the working hours are also getting shorter in many parts of the world. With irrigation the problem is much less tractable, only with the development of remote controlled techniques of regulating the water supplies it has become possible for farmes to live away from the holdings.

Among the consequences that follow, considerable interest attaches to the evidence of increasing farm size in technically and economically advanced countries. Some confusion seems to arise, with regard to 'the agglomeration process' relating to the land holding on one hand and to the farmstead location on the other.

Chisholm concludes with a useful discussion on the technical and economic reasons for the decreasing relative importance of transport costs and, thus, of the distance factor and notes some of the consequences for agriculture.

In Africa, Hovath, J.R.(1969) in his study on "Von Thunen's Isolated State and the area around Addis Ababa, Ethiopia" has attempted a comparison of the agricultural patterns in the immediate vicinity of Addis Ababa's hinterland. In this study inspite of certain basic differences of assumptions and influencing factors, several striking empirical parallels are observed.

An area with a radius of 20 miles was arbitrarily choosen centering on down town Addis Ababa located at 8000 feet above mean sea level in the centre of Highland Ethiopia in Soha Province. With a wet and dry temperate climatic regions and fertile soils, the area is cut across into two with water courses in the north flowing to the Blue Nile and that in the south flowing into the Awash Systems. Addis Ababa and its environs with four main ethinic tribal groups and a foreigner community of Americans, Arabs, Indians, Greeks, Italians, and a variety of others from the west was suffering from a chronic shortage of fuel and building materials within a decade of its establishment when the first eucalyptus tree was imported from Australia. Today Addis Ababa's bulk supply of wood comes from the forest proper, however, the actual woodshed extends beyond this forest. Hence, the existance of a forest growing in close proximity to the city represents striking parallels to conditions stated in 'Isolated State". The more important is the shape of the forest that resembles the theoritical patterns suggested by Thunen, which has resulted from the introduction of an improved transportation surface into the 'Isolated State' along which costs were drastically reduced. All weather roads and mechanised vehicles serve precisely the same function in Ethiopian case. Slight changes in the wedge shaped pattern of the forest cover are observed on account of an east-west steep escarpment with the northern side of the Entotto Mountians and also where soils change from red to black volcanic soils which are apparently too hard to the roots of tender eucalyptus. Eucalyptus forests are also found around other small town over much of Ethiopia in accordance with the idea that the secondary towns of the 'Isolated State' would produce its own landuse zones.

Though vegetables are grown near the city, yet, they do not constitute a first zone and eucalyptus trees a second zone because they are in fact intermingled. The vegetable producing area showing linear distribution that may be attributed to the availability of irrigation water from river during the nine month dry season. At the same time vegetables are cultivated as close to Addis Ababa as possible. A few vegetable producing areas have been developed on streams near all weather roads for quick movement to the market by trucks.

At this stage what is worth noting is that unlike the 'Isolated State' milk and vegetables are not produced together. In Addis Ababa milk production is a seperate enterprise. Until late 1950's, the factor of distance was more in operation to meet out its demand in the city.

However, in late 1950's, a co-operative scheme between Ethiopian Goverment, UNICEF and the peasants was instituted. A plan was made to establish 60 milk collecting centers throughout Addis Ababa's hinterland each with a radius of 3 miles. The milk collected from these centres was transported to Addis Ababa in special trucks. Consequently, the milk shed was considerably extended towards the north. Today Addis Ababa's milk shed comprises of two parts - the traditional system which prevails very close to the city within two-hour walking zone, and the second modern system providing taps further away.

Beyond eucalyptus forest, mixed farming is practised by Galla and Amhara peasants. However, Thunen's three mixed farming zones with decreasing intensity outwards, are not found in Ethiopia for its different institutional development. This type of zonation is attributed to merchants residing in Addis Ababa or in other small towns within the study area where people buy rural surplus from peasants themselves rather than the farmers bring their surplus to the market as suggested by Von Thunen.

Among the wild products, grass for thatching, weaving, animal feed and floor decoration were perhaps the most important commercial item supplied to Addis Ababa during the first half of its history. A parallel with Thunen's Isolated State is seen where the production of straw, clover, and other items of low value and high bulk were produced in the first zone around the city.

The evidences in favour to Thunen's model are met in Etheopia where it is considered that a second small town would also create its own zones of agricultural production. In the study area all the smaller towns have eucalyptus plantations in or around them. However, no vegetable production zone developed specifically in response to the smaller towns. Many of the residents of the towns owned cows for milk and grazed their animals in the immediate environs of the towns.

Despite the fact that all of the Thunen's assumptions were not met in the study area, the agricultural patterns have close resemblance with the theory of location of crops proposed by Von Thunen.

Sonia de Oliveria Leao (1983) studied the evolution of agricultural landuse patterns in the state of Bahia (Brazil). The study extends over a long period of time from the begining of colonisation in 1549 upto 1970. The study reveals the following findings.

1. Bahia was an 'Isolated State' from 1549 to 1930. Commercial agriculture originated in Bahia in the second half of the sixteenth century under the laboratory conditions resembling to those postulated by Von Thunen for 'The Isolated State'.

   There was a relative physical uniformity in Bahia's coastal area; large estates were granted to aristocratic colonists; sugar prices were relatively steady in the Eurpean Market; there was a high mode of transportation which was cheap in terms of coastal shipping but very costly in terms of transoceanic freight; and Salvador was founded and functioned as the major local market.

Bahia was not a real 'Isolated State' in the strict sense of the term since, it maintained trade relation with Portugal. The fact that Bahia's agriculture had to supply commodities to the two seperate markets of Salvador and Portugal, it contributed to the development of an agricultural landscape which formed an economic standpoint and was similar to that predicted by Von Thunen for the "Isolated State".

2. Bahia was transformed from a peripheral location within a wider 'Isolated state' from 1931-1970.

1930 onwards the economic system of the world under-went striking changes which drastically affected the Brazilian economy. External and internal processs gave rise to a belated integration of the Brazilian spatial system which resulted in the break down of Bahia's Isolation within the country and the comparison of Bahia with 'Isolated state' is this period of agricultural evolutilon became increasingly complex. Since trade isolation and high cost of tranportation, are difficult to meet in the real world at later stages of economic and technological developments, the verification of the Thunen's landscape become more and more difficult even in underdeveloped countries.

Sonia de O. Leao after applying a multiple regression concluded that :

(a) Distance is not the best predictor to explain spatial variation of agricultural intensity of Bahia from 1940-1970.

(b) The location of agriculture in Bahia at the present time is primarily explained by physical rain-fall and tenurial (farm size) variables rather than an economic variable (distance) alone. This explains the persistance of traditionalism in Bahia's agriculture, howerver, modification of Von Thunen's model is also necessary. When the isolation of spatial system collapses, the deviation between reality and model tends to increase.

(c) Evidence suggests that, at the present time the verification of Von Thunen's model seems to be more appropriate at the Brazilian scale.

(d) The use of multiple regression to measure the relationship between variables over the time proved to be a powerful tool to show changes in their effects. There appears to be a continuing decrease in the average size of farms producing temporary crops and conversely a continuing increase in the average size of farm producing beef.

(e) Lastly, despite the statistical significance of the set of variables selected, there still remained a high amount of unexplained variation in the intensity of Bahia's agricultute. This reinforces the necessity for a multvariate analysis approach in geography.

In India, several scholars have attempted to assess and evaluate the Thunonian model of agricultural location. A seperete chapter on this account deals at length about the contributions made by different scholars in this direction. However, a brief account of these contributions is mentioned here. Blaikie, P.M. (1971) made a profound study for the investigation of cropping patterns of four villages selected from north India. In his study, Blaikie reached the conclusion that isotrophism is severely disturbed by irrigation dominance and, that movement minimisation cirteria are unimportant. Well Irrigation provides a facility to irrigate a small circular area with a high degree of reliability while canal irrigaion expanding over large areas is variable in quality of irrigation. Distance as a factor of location in agricultural activities of these villages is reduced to intra-crop input levels in certain crops only. Here water is important than distance.

Shafi, M. (1977) in a comprehensive landuse study of 35 villages of Koil Tehsil of Aligarh district (Uttar Pradesh) reached the conclusion that, there is no impact of distance from the settlement on the intensity and location of crops, both on macro-level as well as micro-levels. However, it is the distance form the canal, the source of irrigation or the number of tube-wells which has a bearing on the intensity of cropping and location of certain crops mainly in Rabi cropping season.

The other study on the locational analysis of crop land use was conducted by Fakhruddin and Khan, M.F. (1981). The study area was Tehsil Unnao of the district Unnao (Uttar Pradesh). Concluding their study, Fakhruddin and Khan, uphold Shafi's proposition that the location of crops and the intensity of land use is a function of distance from the source of irrigation. rather than the distance from the urban centre.

Raina, J.L.(1989) conducted a collective study of 137 villages in Jammu district of Jammu and Kashmir in which the focus of attention was precentage of different crops in each cropping season and the level of intensity of cropping considering double cropped area for this purpose. Raina as per his findings, concluded that Von Thunen's model under Indian condition is not applicable. The intensity of agicultural landuse in the villages of Jammu district does not show any relationship with varying distances from the settlements. However, it shows an association with varying distance from irrigation facilities.

AIMS AND OBJECTIVES

The aims and objectives of the present study are to test the following hypotheses both at macro-level i.e., regional scale and at micro-level i.e., village scale.

Hypotheses for Macro-Level Study

1. With increasing distance from the urban settlements (market centre), the intensity of cropping decreases. This hypothesis is tested because according to Von Thunen, the intensity of cropping decreases towards the margin of cultivation. It also seems to decline with distance from railways and highways, because as perceived by the researcher, the application of the doses of inputs

is also affected with increasing distance/decreasing accessibility from the lines of communication.

2. With increasing distance from the canal i.e., decreasing intensity of canal irrigation, the intensity of cropping decreases. Since in semi-arid climate of the region water is the main input to agriculture, canal irrigation brings about perceptible changes in the intensity of cropping.

3. With increasing intensity of tube-well irrigation, the intensity of cropping increases for the reasons mentioned above.

4. The locational distribution of cereals, pulses and oil seeds will increase or in other words, the intensity of cereals, pulses, and oil seeds cultivation will decrease with increasing distance from the urban settlements while that of vegetables and fodder will decrease at macro-level. According to Von Thunen those crops which are less intensive like cereals find more favourable locations at some distance away from the settlement while crops like vegetables which are in much demand in cities and are perishable, occupy a location near the market-places. Fodder show a declining locational trend away from the cities because of its low-value and bulky nature.

5. Following the same reasoning mentioned above, the locational

distribution of cereals, pulses and oil seeds will increase while that of vegetables and fodder will decrease with increasing distance from railways and highways, since accessibility decreases with increasing distance from them.

6. With increasing distance from the canal or decreasing intensity of canal irrigation, the locational distribution of cereals (Kharif), pulses, fodder and oil seeds will increase, as these crops require comparatively less amount of water. While the area under cereals (Rabi) and vegetables will decrease, because they require much water for being grown.

7. In angular zoning with increasing intensity of tube-well irrigation the locational distribution of cereals (Kharif), fodder, pulses and oil seeds decreases since these crops require less amount of water, while that of cereals (Rabi) and vegetables will increase.

Hypotheses for Micro-level study

8. With increasing distance from the village settlement, the intensity of cropping decreases. This hypothesis is formulated for being tested, because soil fertility and the level of inputs decline gradually with distance from the village settlement.

9. The locational distribution of Kharif cereals, pulses, fodder and oil seeds will increase with increasing distance from the village

settlement, because these crops need less amount of water for their cultivation. The fodder crops are of low-value and high-bulk in nature and their cultivation is extensive, moreover, the distances involved at village scale are comparatively smaller.

10. With distance from the village settlement the locational distribution of Rabi cereals specially wheat will increase particularly in villages with assured irrigation facilities, because high yielding varieties of wheat, the dominant Rabi cereal require several waters during its field life.

11. The locational distribution of vegetables will decrease with increasing distance from the village settlement. The reason for this type of pattern is that vegetable fields need much attention and field visits of the cultivators for the purpose of protection from stray animals.

SELECTION OF THE STUDY AREA

The district of Gurgaon was selected for the purpose of this study because it enjoys many types of variations and diversities in terms of relief, sub-surface water conditions, ethnic and cultural variations, variations in the literacy levels and in the patterns of irrigation systems. The northern part of the district which includes the Community Development Blocks of Gurgaon, Farrukhnagar, Pataudi and Sohna are dominantly inhabited by Jat, Ahir and Gujar communities while the southern part of the district which includes the Community Development Blocks of Nuh, Taoru, Nagina, Punhana and Ferozpur Jhirka are mainly inhabited by muslim Meo community. The depth of the underground water ranges between 10 to 30 meters for the northern part of the district and 0 to 10 meters for the sourthern part of the district. Moreover, the quality of underground water for the northern part of the district is generally good for irrigation and ranges between 0-400 Micro MHOS/CM at 25 °C in terms of electrical conductivity. For the southern part of the district the range of electrical conductivity is between 4000-6000 + of Micro MHOS/CM at 25°C. Hence, the sub-surface water comparatively in large areas of the southern part of the district is marked with high degree of salinity which renders it as unsuitable for being used for irrigation purposes. In the absence of canals/pernnial canals in several blocks of this sourthern part of the district mainly in Nagina, and Ferozpur Jhirka the percentage of the area irrigated is 12.24, and 25.56 respectively, as against the district average of 55.85 per cent. Hence, this sourthern part of the district heavily depends upon rainfall for agriculture.

The total rural literacy for the northern part of the district ranges between 58.25 - 62.37 per cent while the same for the southern part of the district is between 25.68 - 41.83 per cent as against the district average of 46.00 per cent (District Census Handbook, Gurgaon, part XII - A & B, Series - 8, 1991).

THE DATA SOURCE

For the present study data from different sources were collected. The major portion of the data was taken from unpublished village records-the Lal Kitabs and Khasra Khatoni i.e., the records lying with Patwaris (The village record officers). From these sources, village level data were collected. These data pertaining to various aspects of the problem under study are about the total area of the village, forested area, area not available for cultivation, barren and uncultivable waste, net sown area, gross cropped areas, irrigated area, acreage under food grains, pulses, gram, vegetables, fibre crops, oil seeds, green fodder and others for both Rabi and Kharif cropping seasons.

Valuable information about the depth of under ground water, its seasonal fluctuations, the quality of ground water in term of electrical conductivity and other relevant informations were provided by Ground Water Cell, Department of Agriculture, Gurgaon, Haryana.

The Soil Testing Laboratorty, Gurgaon provided informations about various types of soils found in Gurgaon district along with their inherent physical and chemical properties. District Census Handbook of Gurgaon (Series -8 part XII-A & B, 1991) was used for collecting data pertaining to demographic variables and source wise irrigation at block / village levels. The base map of district Gurgaon was also taken from this published report of District Census Handbook. The maps for villages were obtainet from the Agricultural Department, Tehsil Headquarters.

Indian Meteorological Department provided relevent climatic data of the various observatory stations located in the district of Gurgaon.

The other government offices like District Statistical Office, Mewat Development Borad and District Agricultutre Department also provided relevent informations about other aspects of the study like mechanisation of agriculture.

METHODOLOGY

Data Generation at Macro-level

The present study is planned at two levels. A macro-level approach deals with circular zoning around urban settlements, oblonged zoning along railway, parallel zoning along highway and canal as well as angular zoning around the urban settlements. In each case of zoning, six zones each of two kilometers width were drawn from the point of origin up to a distance of twelve kilometers.

At macro-level, an indepth study of 92 sample villages of Gurgoan district is carried out. Attention was focussed on the percentage of different crop groups in both Rabi and Kharif seasons of 1993-94 as well as intensity of double cropping. The following schemes of zoning were adopted for the present study.

In case of circular zoning around urban settlements, the cities of Gurgaon and Nuh were selected. Gurgaon, an urban agglomeration with a population of 1,35,884 persons (Census of India, 1991) is about 30 kilometers from the Delhi, while Nuh with a population of only 7492 persons (Census of India, 1991) a small town is further 45 kilometers away from Gurgaon on Delhi-Alwar State Highway No. 13. It was, therefore, considered that the urban influence on the agriculture in the hinterland of Gurgaon would be on account of additional external urban influence of Delhi. In case of Nuh, with its own small area of influence, the agriculture must respond to its well pronounced indigenous socio-economic impulses.

Circular zoning around the cities of Gurgoan and Nuh at an interval of 2 kilometrs upto a distance of 12 kilometers was carried out in order to assess the impact of distance from the settlements on the intensity of cropping as well as on the locational patterns of cropping.

Oblonged zoning along Delhi- Jaipur Railway at an interval of 2 kilometers up to a distance of 12 kilometers was carried out in order to study the impact of railway, if any, on intensity as well as on the locational patterns of cropping.

Parallel zoning along Delhi- Alwar State Highway No.13 (Nuh-Nagina Part) at an interval of 2 kilometers for a distance of 12 kilometers was done for the assessment of the impact of accessibility, if any, on the cropping intensity and locational cropping patterns.

Parallel zoning along Patakpur-Minor Distributary of Gurgaon Canal was taken up at an equal interval of 2 kilometers upto a distance of 12 kilometers along the eastern bank. It was aimed at to find out the influence of the availability of irrigation facilities on the intensity of cropping and locational cropping patterns, if any.

Angular zoning around the city of Sohna was carried out in order to find out the impact of tube-well irrigation on agriculture. For this purpose taking Sohna as the centre, a semi-circle with a radius of 12 kilometers was drawn to the west of Sohna. This semi-circle was divided into six angular zones in clockwise direction each of 30 degrees width. In each zone for the sample villages, the total number of tube-wells were recorded. Around Sohna, the quality of sub-surface water is generally good from view point of irrigation.

Angular zoning around Nagina, taking Nagina as the centre and a radius of 12 kilometers, was carried out to the east of Nagina in the same fashion. In each angular zone for the sample villages, total number of tube-wells were recorded. Around Nagina the sub-terranean water is generally saline and is not very much suitable for irrigation purposes except at few locations. Hence, agriculture to a great extent is rainfall dependent.

For parallel zoning along the Patakpur Minor Distributary of Gurgaon Canal, the distance form the canal was taken up as independent variable : while in the case of angular zoning about Sohna and Nagina the intensity of irrigation in each angular zone was considerd as independent variable for the assesssment of cropping pattern and intensity of cropping in the area.

As far as the sampling of the villages is concerned, for each category of zonation and for each zone in every category, a stratified random sampling was carried out taking the size of the sample as 20 % for each zone separately. In this way with 20 % sample size for all zones and all categories taken together out of 451 villages, 92 villages were selected for the present study on macro-level (Fig. 1, Appendix-I).

The crops data collected for each village were clubbed together in several categories of crop groups like cereals, vegetables, oil seeds, pulses, and fodder separately for both Kharif and Rabi cropping seasons (Appendix-II).

For all the villages, lying in each zone, the corresponding acreage values of various crops/crop groups and other categories like net sown area and double cropped area, both for Rabi and Kharif cropping seasons were added up separately and their percentages were calculated by taking net sown area in the denominator.

Statistical treatment of data was done using simple bivariate correlation and regression analyses. Student's t-test was applied on regression coefficients to test the formulated hypotheses. For this purpose, independent variables selected were (a) the average distance of each zone from its point of origin i.e., 1, 3, 5, 7, 9, and 11 kilometers (b) zone-wise intensity of irrigation in case of angular zoning about Sohna and Nagina. The rest of the variables were dependent variables like, double cropped area, and the various categories of crops/crop groups.

DISTRICT GURGAON

LAYOUT OF SELECTED ZONING PATTERNS

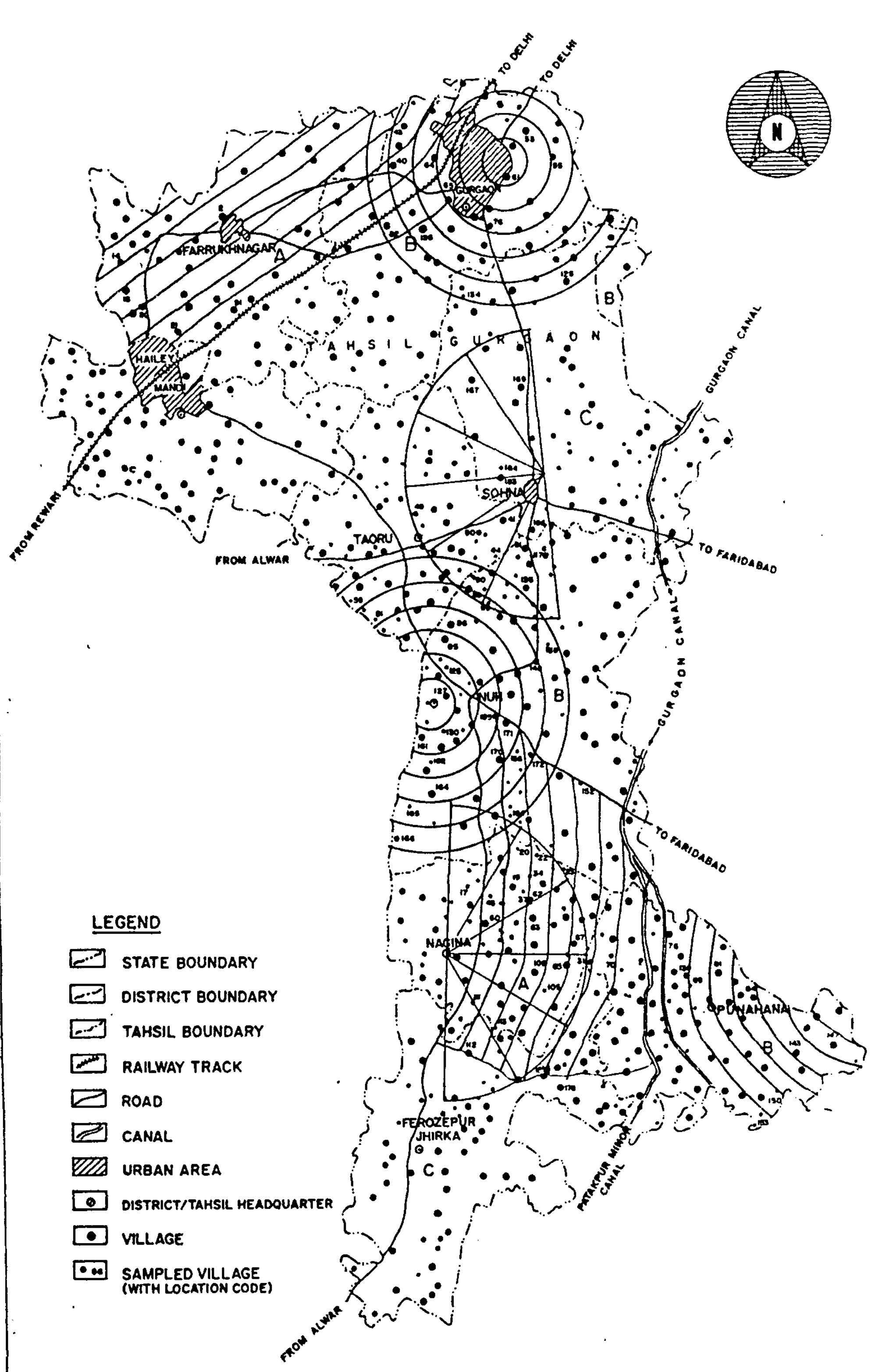


Fig.I

For each pair of variables, a scatter plot along with least square line was plotted in order to study the trend and strength of relationship.

In corresponding zones of each zoning schemes the percentages of cropping intensity and the area under various crops/crop groups both for Rabi and Kharif cropping seasons were calculated with respect to net area sown, and were plotted in the form of line graphs. These line graphs show the percentage of crop groups along the ordinate and distances from the settlements/railway/highway/canal along the abscissa. In case of angular zoning around Sohna and Nagina, since number of tube-wells were of less significance as compared to intensity of tube-well irrigation, hence, intensity of tube-well irrigation was selected as independent variable and plotted along abscissa for the purpose of research. Scatter plots with least square line as well as statistics about correlation, regression and student's t-test were also worked out in order to help interpretation of the results with some level of confidence.

Data generation at micro-level

The second part of the study is based on micro-level investigation, which is related to the study of individual villages. In order to satisfy each of the following criteria, a representative village was selected through purposive sampling.

1. Less than 2 kilometers from a small town and far away (more than 2 kilometers) from railway, road, and canal and having a great dependency upon rainfall for agriculture, so that the influence of a small town on the crops could be assessed.

2. With maximum area put to the tube-well irrigation and far away (more than 2 kilometers) from any of the city, road, railway and canal, so that the sole influence of tube-well irrigation could be assessed.

3. With maximum dependency on rainfall for cropping, and far away (more than 2 kilometers) from any of the city, road, railway and canal, so that locational patterns of crops in a rain-fed agriculture system could be studied.

4. At a distance of less than 2 kilometers from a road/railway-the transportation artery and far away (more than 2 kilometers) from city and canal within rain-fed agriculture system, so that the influence of road/railway (i.e., accessibility) on the location of crops could be assessed.

5. Less than 2 kilometers from canal with maximum area under canal irrigation, and far away (more than 2 kilometers) from city, road, railway so that the influence of canal/canal irrigation on the location of crops could be assessed.

6. Less than 2 kilometers from a big city, and road together with maximum area put to tube-well irrigation, and far away (more than 2 kilometers) from canal so that the combined influence of big cities, easy accessibility, and tube-well irrigation on the location of crops could be assessed.

Taking the core of the village settlement as the centre of the village, the land surrounding the village settlement was demarcated into six concentric rings of almost equal width. The total area lying under each zone was computed by using square method with the help of a graph paper. The area put under various Rabi and Kharif crop groups like cereals, vegetables, fodder crops, oil seeds, and pulses, as well as double cropping were computed for each zone and the percentages were calculated. A simple bi-variate correlation and regression, as well as, t-statistic were also worked out. Proper cartographic representation of these individual villages using maps, poly-graphs and scatter plot was also taken up.

ORGANISATION OF THE WORK

The study is initially aimed at identifying the impact of distance and intensity of irrigation in determining cropping patterns and cropping intensity. Therefore, the whole study is designed in such a way as to cover not only the central theme but also the fringing aspects influencing the outcome of the study.

Since the agricultural landuse patterns and location of crops is an outcome of interaction between various natural and cutlural factors therefore, Chapter-I deals with the environmental framework of the study area. It deals with the general physical back ground, human resource base, irrigation systems, and agricultural profile of the Gurgaon district.

The conditions of market economy which led to the evolution of Thunen's agricultural landscape is markedly different in this century in India. Therefore, the Chapter-II takes a review of the factors which affect the location of crops in agricultural scenario specially in an Indian economy.

Since the concept of rent and economic rent was the main driving force behind the evolution of the Thunen's model of agricultural location, hence, in order to have a good comprehension of the Thunen's model, a descriptive account about the concept of rent and economic rent is attempted in the form of Chapter-III.

The applicability of Thunen's model requires an understanding of the model itself. However, the conditions thought to be conducive for the evolution of the basic assumptions are changing fast in a changing world. Therefore, Chapter-IV deals with the crop location theory of Von Thunen at length focussing upon a critical evaluation of Thunen's hypothesis.

Under varied physical, socio-economic conditions, Von Thunen's model has been applied for being tested in different parts of India by several scholars. Therefore, a critical appraisal of the work done is attempted in Chapter-V. It provides a base to carry over the present study to further testing of hypotheses in the study area.

In order to identify the patterns of cropping intensity and the location of crops with respect to various factors of location, two approaches are followed. chapter-VI is devoted to study the location of crops and cropping intensity at macro-level around the urban settlements, along linear features like roads, railways and canals, as well as, in angular zones about some urban settlements.

Chapter-VII tries to bring about the variations in the location of crops and cropping intensity at micro-level that is at village scale. Six villages are selected after purposive sampling so that each of the village is satisfying a certain criterian laid down for the purpose of hypothesis testing.

The entire study is, therefore, is contained in seven chapters which are followed by conclusion and suggestions and the formulation of a new model of agricultural location of crops for the study area.

CHAPTER - I

ENVIRONMENTAL SETTING OF THE STUDY AREA

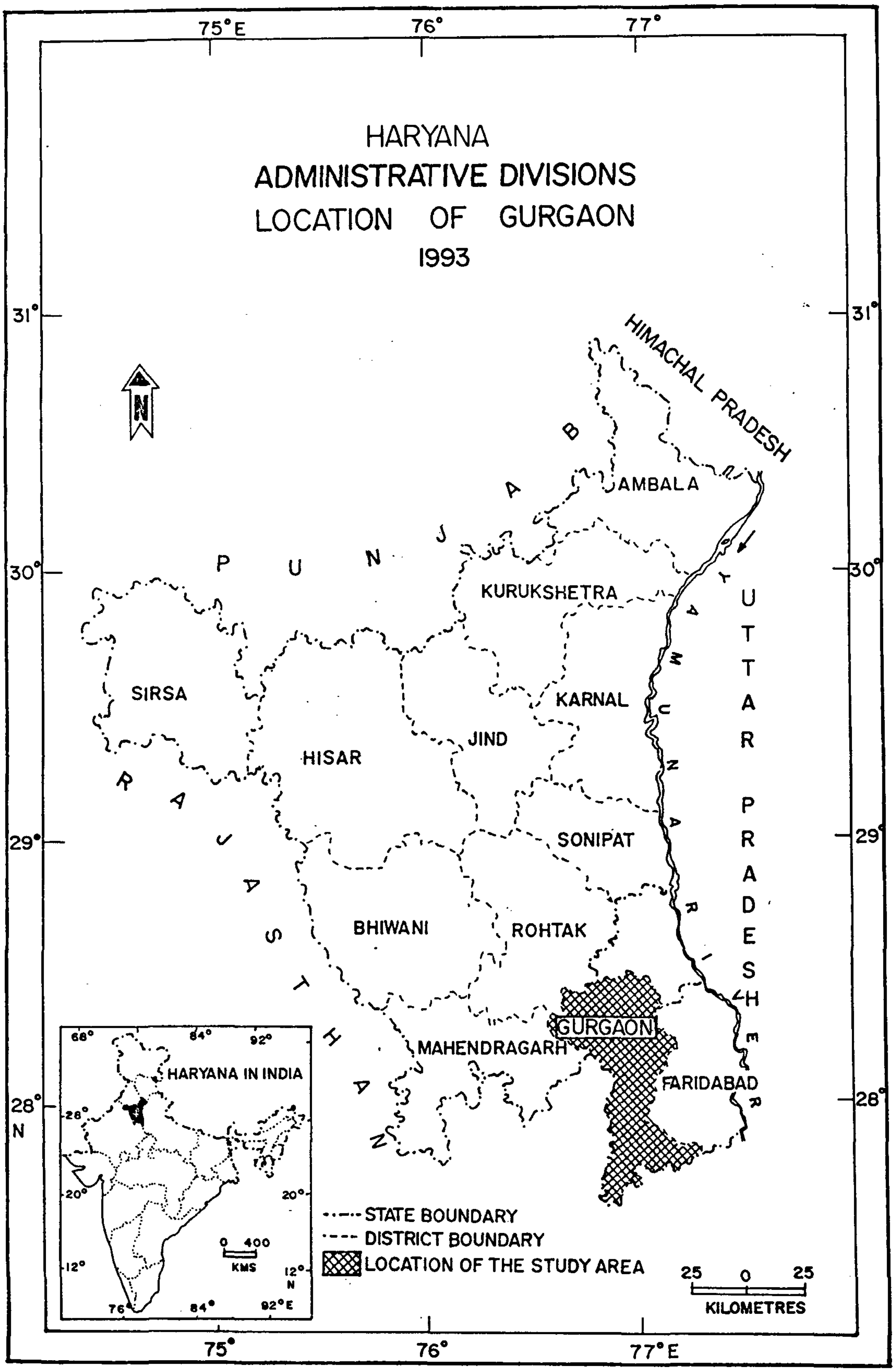
The district of Gurgaon, a part of Southern Haryana Plain, is named after the name of its city headquarter, Gurgaon. Always being under the sway of Delhi rulers, the district of Gurgaon has perhaps derived its name from a Hindi word Guru Gram, meaning thereby - the village of a teacher, most probably a spiritual one, or otherwise this village was considered Guru or big, meaning a big village.

LOCATION AND ADMINISTRATIVE DIVISIONS

With a geographical area of 2675.0021 square kilometers (259.37 thousand hectares) it extends between the geographical co-ordinates of 27° 39' 40" N to 28° 31' 05" N and 76° 39' 40" E to 77° 20' 15" E and falls within the limits of the survey of India topographical sheets numbering 53D, 53H, 54A and 54E.

The district of Gurgaon is bounded by the districts of Faridabad (Haryana) in the east, and Rewari district (Haryana) in the west. To the South it is bounded by Alwar and Bharatpur districts of Rajasthan State. The state of Delhi and Rohatak district of Haryana forms the norhtern boundary of the district (Fig. 1.1).

The district of Gurgaon (Fig. 1.2) is composed of three sub-divisions viz. Gurgaon, Nuh, and Ferozpur Jhirka. These three sub-division are divided into four tehsils namely Gurgaon, Pataudi, Nuh and



HARYANA
ADMINISTRATIVE DIVISIONS
LOCATION OF GURGAON
1993
75°E
76°
77°
31°
30°
29°
28°
N
HIMACHAL PRADESH
PUNJAB
RAJASTHAN
UTTAR PRADESH
YAMUNA RIVER
AMBALA
KURUKSHETRA
KARNAL
SIRSA
HISAR
JIND
SONIPAT
BHIWANI
ROHTAK
GURGAON
MAHENDRAGARH
FARIDABAD
HARYANA IN INDIA
0 400
KMS
STATE BOUNDARY
DISTRICT BOUNDARY
LOCATION OF THE STUDY AREA
25 0 25
KILOMETRES

Fig.I.I

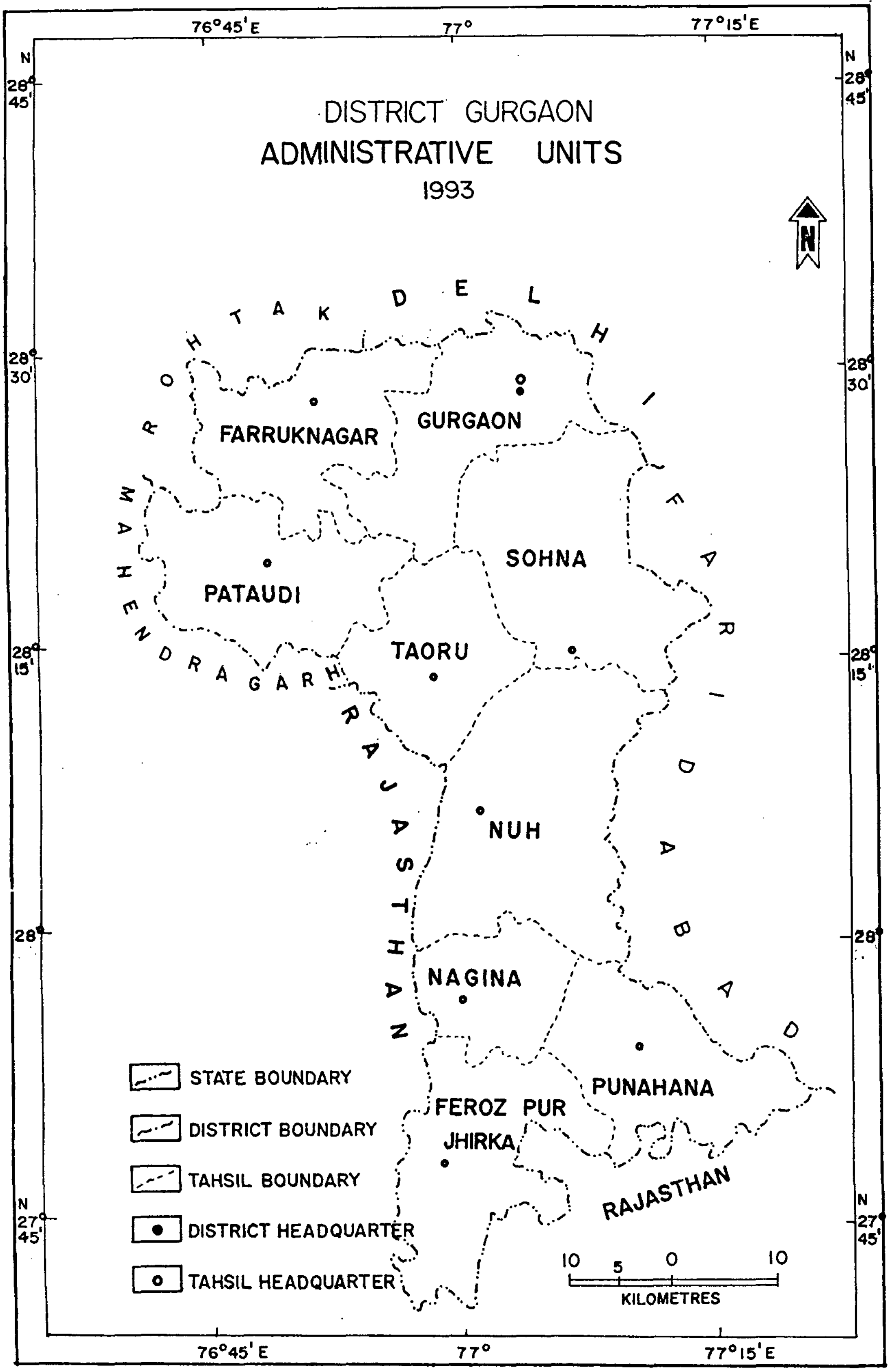

DISTRICT GURGAON
ADMINISTRATIVE UNITS
1993
76°45'E
77°
77°15'E
N
28° 45'
28° 30'
28° 15'
28°
27° 45'
ROHTAK
DELHI
FARIDABAD
MAHENDRAGARH
RAJASTHAN
FARRUKNAGAR
GURGAON
PATAUDI
SOHNA
TAORU
NUH
NAGINA
PUNAHANA
FEROZ PUR JHIRKA
STATE BOUNDARY
DISTRICT BOUNDARY
TAHSIL BOUNDARY
DISTRICT HEADQUARTER
TAHSIL HEADQUARTER
10 5 0 10
KILOMETRES

Fig.I.2

Ferozpur Jhirka. These four tehsils are further sub-divided into nine Community Development Blocks (Table-1.1).

Table - 1.1

DISTRICT GURGAON AT A GLANCE

Tehsils	C.D.Blocks	Area (000' hect)	No.of Inhabited/ (Uninhabited Villages)	Towns with Civic status
1. Gurgaon	Farrukhnagar	27.4	52 (2)	Farrukhnagar (M.C.)
	Gurgaon	32.29	72 (2)	Dundahera (C.T) Gurgaon U.A. (M.C.) Gurgaon Rural (C.T.)
	Sohna	30.70	71 (5)	Sohna (M.C.)
2. Pataudi	Pataudi	23.17	75 (6)	Hailymandi (M.C.) Pataudi (M.C.)
3. Nuh	Taoru	21.73	80 (4)	Taoru (M.C.)
	Nuh	45.27	107 (12)	Nuh (M.C.)
4. F.erozpur Jhirka	Nagina	21.52	67 (1)	—
	Punhana	25.45	83 (9)	Punhana (M.C.)
	Ferozpur Jhirka	31.83	81 (1)	Ferozpur Jhirka (M.C.)
District Gurgaon		**259.37**	**688 (42)**	

Note : M.C. = Municipal Committee C.T. = Census Town
U.A. = Urban Agglomeration
(Figures in parantheses show uninhabited villages)

The chapter deals with the general physical background of the study area. it also discusses other sections pertaining to human resource base, irrigition systems and agricultural profile of the study area besides the physical background of the region.

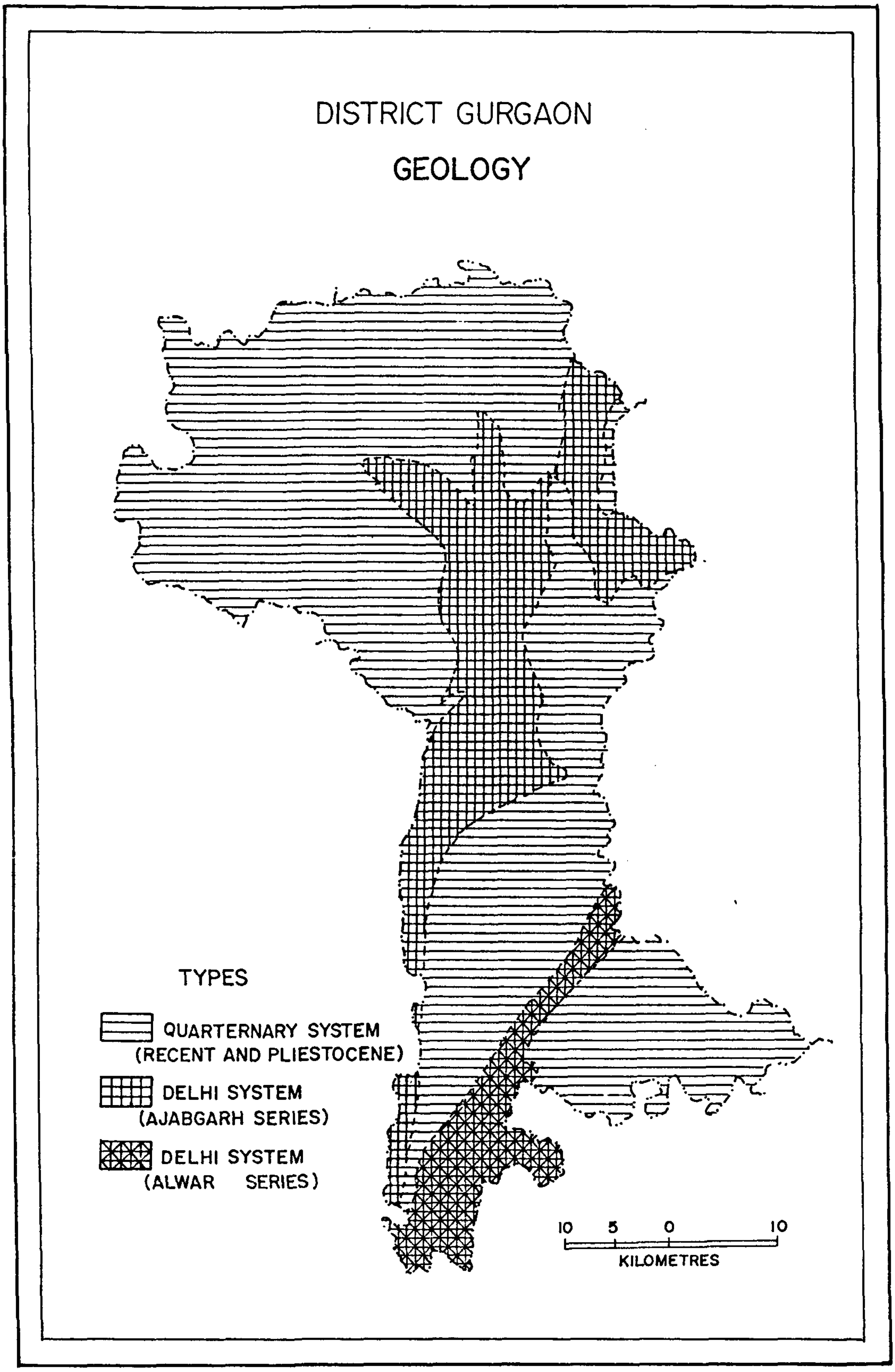
PHYSICAL SETTING

This section of physical background of the study area covers the general topics of Geology, Geomorphic regions, Climate and Natural Vegetation, Drainage, Hydrology and Pedology of the study area.

GEOLOGY

The district of Gurgaon consists of rocks ranging from Archaean to Recent geological age. Aravallis are the oldest rock formations of nearly 2500 million years old. These rocks consist of schist and quartzite with intrusions of granite. The geological formations (Fig. 1.3) which appear in the district are Banded Gneissic Complex, Raialo Group, Delhi Super Group and Recent Alluvium. The Banded Gneiss comprises of granite, quartzite and schist. The Raialo Group consists of feldspathic quartzite and marble. The Delhi Super Group is composed of quartzite with mica schist and quartzite, schist, dolomite and phyllite (Ajabgarh Group). The rocks of Delhi Super Group are intruded by metadolerite and granite.

The newer alluvium and older alluvium are found extensively in the area. These comprise of silt, sand, gravel, clay, and kankar. The older alluvium is found in enormous extensions in the area lying to the west of Sohna Ridge. The area to the east of this Sohna Ridge is occupuid by



SOURCE - KHAN, S. AND QURESHI, M.A., 1997. CHANGE DETECTION IN WASTELANDS USING GIS AND REMOTE SENSING, NISCOM, NEW DELHI - 110012.

Fig.1.3

newer alluvium. Sand dunes are also present in this area. The Alwar series comprises of quartzites, mica schists with pegmatite intrusions and forms a ridge aligned in north-south direction in the western part of the area. The Alwar Series also consists of another ridge which is aligned in north-east to south-west direction and lies in the north-western part of the distict . The Ajabgarh series is made up of the slates, phyllites and quartzites. It forms a north north-east to south south-west trending ridge in the south-western part of the district Gurgaon.

GEOMORPHOLOGICAL REGIONS

The district of Gurgaon with a relief of rolling plain is dominated by the extension of dissected Aravalli spurs, with a variable gradient ranging between 3-6,6-13, and above 13 in terms of degrees of slopes. The hillocks are dissected by rainfed torrents. The soils of the district are light soils, mainly relatively sandy loam, medium soils particularly the light loam (Seoti), the loam (Bhanger and Nardak); the Coarse Loam (Dahat and Chaeknote) and the exposed Rocky Surfaces are also found. These soils are classified by NBSS and LUP (ICAR), Nagpur as Orthids-Fluvents, Ochrepts-Usterts-Ustalfs type of soils.

The district is broadly classified into following four geomorphic regions (Fig. 1.4) on the basis of soils, topography and natural vegetation.

The Gurgaon-Pataudi-Sahibi Plain

It spreads over the northern and north-western parts of Gurgaon district and is bounded by the state of Delhi in the north, Rohtak district

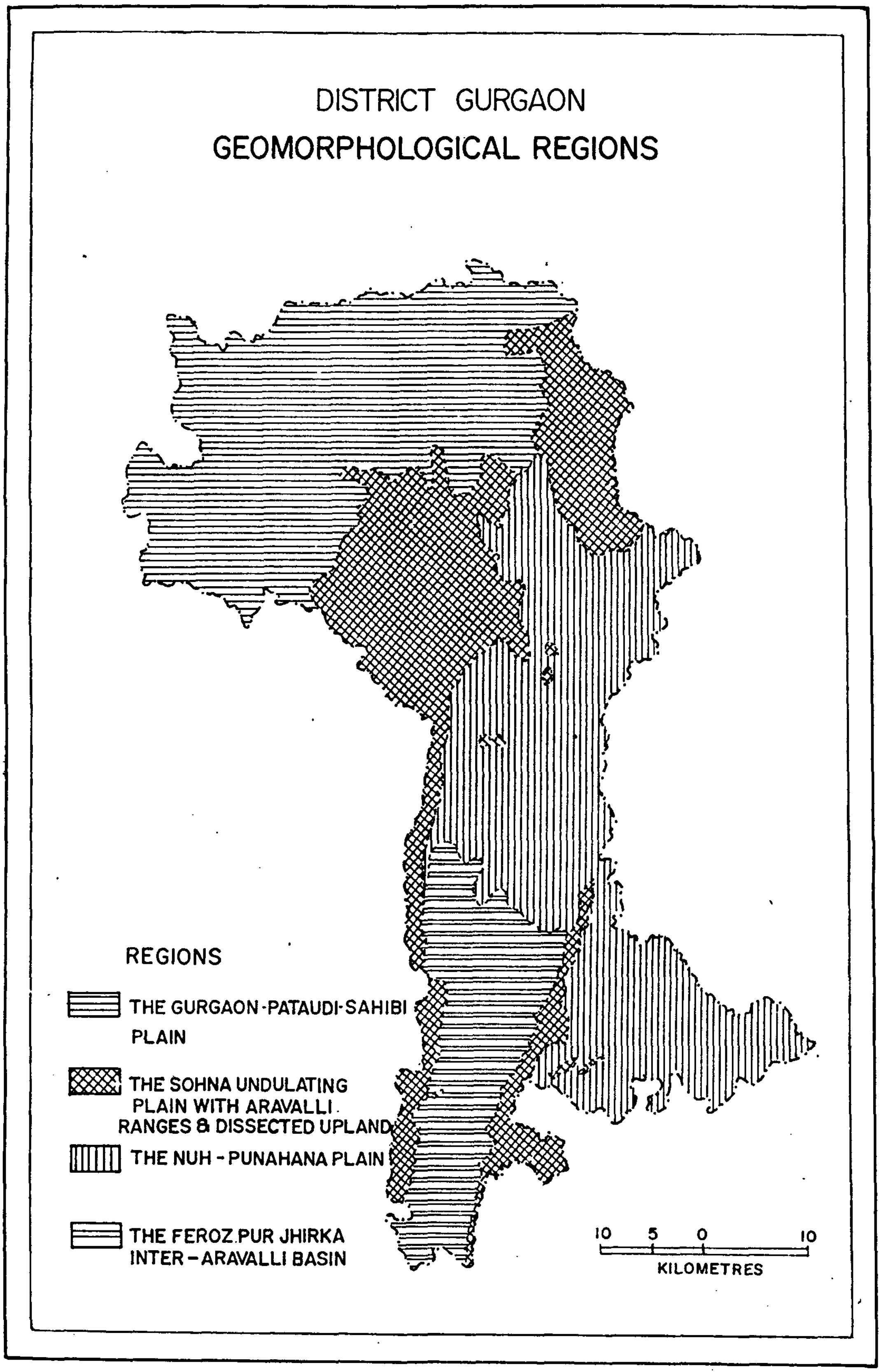

DISTRICT GURGAON
GEOMORPHOLOGICAL REGIONS
REGIONS
THE GURGAON-PATAUDI-SAHIBI PLAIN
THE SOHNA UNDULATING PLAIN WITH ARAVALLI RANGES & DISSECTED UPLAND
THE NUH - PUNAHANA PLAIN
THE FEROZ.PUR JHIRKA INTER-ARAVALLI BASIN
10 5 0 10
KILOMETRES

Fig.1.4

in the north-west, Rewari district in the south-west, and Sohna Undulating Plain with Aravalli off shoots in the east and south-east. The region as a whole, is a plain area under extensive cultivation with the exception of few patches of land covered with bushy and scrub type of vegetation. With Delhi Group (Middle Proterozoic) formation this region is having a maximum height of 276 meters above mean sea level near the village Gausgarh. The minimum height of this region is found to be 217 meters which is found near the village Garhi Nathe Khan. Generally, the contour of 220 meters covers almost the entire region. The region is quite homogenous up to Sahibi river which is in the extreme north-western part of the district.

The soils found in the region are relatively sandy loam to light loam. Sandy Loam stretches between the sandy soils and loam. It needs little ploughing and is capable of retaining moisture, therefore, this soil is considered best for dry farming.

The light soils which are found here, have advantage over the medium soils because it requires less moisture for germination, growth and assured harvest. These soils are capable of producing a variety of crops like wheat, barly and oil seeds provided irrigation is assured. These soils as classified by the NBSS and LUP (ICAR), Nagpur, are Orthids-Fluvents and Ochrest types of soils.

Being homogenous plain with gentle topography and a slope of under three degrees, the transportation facilites are well developed in the region. A railway from Delhi to Rewari passes through the region in north-east to south-west direction and that connects the towns of Gurgaon and Haileymandi. A meter guage railway line is also up to Farrukhnagar. Besides other roads, the National Highway No.8 passes through the region which is almost parallel to Delhi-Jaipur railway. River Sahibi traverses this region which contains 188 villages and six towns, namely Gurgaon, Gurgaon (rural), Farrukhnagar, Haileymandi, Pataudi and Jharsa.

Sohna Undulating Plain with Aravalli Ranges and Dissected Uplands

This region extends over the parts of Gurgaon, Nuh, and Ferozpur Jhirka tehsils and is bounded by Gurgaon plain in the north and north-west; state of Rajasthan in the west; Faridabad district and Nuh-Punhana Plain in the north-east, east and south; and by the state of Delhi in the north-east. The agricultural productivity levels, throughout the region are very poor as compared to Gurgaon plain for reasons of coarse texture of the soils, high infiltration rate and very low moisture retaining capacity, and poor soil cover on rocky areas. Natural vegetation generally is in the form of xerophytic scrubs and bushes. A tract of protected forest is lying in the western side of the region between the Aravalli outcrops and Rajasthan border.

With Delhi Group (Middle Proterozoic) formations, this undulating region due to Aravalli offshoots is having a maximum height of 448 meters above mean sea level at a hillock near the village Bhond in Ferozpur Jhirka tehsil. The minimum height is shown by a bench mark of 198.4 meters near the village Nawli of the same tehsil. The entire region is covered with rocky surface of Aravalli outcrops which form a series of flat-topped ridges.

The pedology of the region states that most of the area which is a barren exposed rocky surface is carrying a thin soil cover. Some of the area is under relatively sandy loam and coarse loam. The soil classified by the NBSS and LUP (ICAR), Nagpur are Orthids-Fluvents, Ochrepts and Ochrepts-Usterts-Ustalfs type of soils.

Sohna, Taoru, and Ferozpur Jhirka are the main towns in this region. Roads diverging from Sohna interconnect the towns of Gurgaon, Taoru, Delhi, Palwal, Nuh and Ferozpur Jhirka. This region is not served by railways. There are 256 villages in this region.

The Nuh-Punhana Plain

The region covers the parts of Nuh tehsil, and northern, central and eastern parts of Ferozpur Jhirka tehsil. The Ferozpur Jhirka part of the region is divided into two parts for Ferozpur Jhirka dissceted Upland falls between them. This dissceted upland is included in the region of Sohna Undulating Plain with Aravalli off shoots.

The first part of this region confines its limits with Sohna Undulating Plain in the north and west, state of Rajasthan in the south-west and Ferozpur Jhirka Dissected Upland, and Faridabad district in the east. The second part of the region shares its boundaries with the Faridabad distirct in the north and north-east, state of Uttar Pradesh in the east, sate of Rajasthan in the south and Firozpur Jhirka Dissceted Upland in the west. This part of the region is a level plain with gentle gradient towards the South Agra Canal and its branches which provide assured irrigation to this eastern part of Ferozpur Jhirka tehsil.

With Delhi Group (Middle Proterozoic) formations this region is having a maximum height of the region - 236 meters above mean sea level near the village Hathan Gaon situated in Ferozpur Jhirka tehsil, while the minimum height in 205 meters above mean sea level near the village Umra lies in the same tehsil.

The entire region is a plain area with coarse loam, loam or alluvial soils. The soils are compact and stiff due to the addition of silt and clay over the years. It is less granular with low water holding capacity. These soils are classified by NBSS and LUP (ICAR), Nagpur as Orthids-Fluvents-Ochrepts and Ochrepts-Usterts-Ustalfs types of soils. On the whole soils are deep, moderately fertile and capable of producing a variety of crops like wheat, gram, barley, pulses and sugarcane.

Nuh, the only town of the region is well connected to the countryside and other cities like Gurgaon, Ferozpur Jhirka and Taoru by a network of metalled roads. After Nuh, the second important place is Punhana in the region which is also a center of communication and a big Mandi of agricultural produce like Nuh. The region contains 200 villages.

The Ferozpur Jhirka Inter-Aravalli Basin

The region covers the middle and south-eastern parts of Ferozpur Jhirka tehsil and is bounded with Nuh-Punhana plain in the north and in the east, the state of Rajasthan in the south and Faridabad district in the north. The eastern parts of the region bordering with Rajasthan consist of Aravalli off shoots and uplands. Dissected lands are found on both the sides of the ridge, which are covered by scrub and bushy vegetation.

With Delhi Group (Middle Proterozoic) formation, this region is having a maximum height of 371 meters above mean sea level near the village Ghata Shamsabad in Ferozpur Jhirka tehsil, while the minimum height is shown by a contour line of 200 meters.

The soils of the region are coarse loam type. At places the region is also covered with rocky surfaces. The soils are classified by NBSS and LUP (ICAR), Nagpur as Ochrepts type of soils which are shallow, black-brown and alluvial soils of the northern region.

Road network in the region in not fully developed on account of dissected and rocky surfaces. However, several villages are served by link roads. The regions consists of 77 villages and the only town of Ferozpur Jhirka.

CLIMATE AND NATURAL VEGETATION

The climate of Gurgaon district is semi-arid, sub-tropical, continental type. Summers are very hot characterised with dusty winds. The mean temperature of the hottest month June is 39.5 degree Celsius, however, the maximum temperature recorded during the summers is 45.0 degree Celsius, The winters are very cold with a mean temperature of the coldest month January as 14.1 degree Celsius, however, the minimum temperature recorded at times during winters is as low as 1.0 degree Celsius, These minima and maxima of temperatures are within the crop tolerance levels. The following Table-1.2 produces an account of monthly temperature variations recorded at Gurgaon for the Year 1993.

TABLE 1.2
Monthly Temperature
Gurgaon
1993

Months	H	L	M
January	25.0	02.8	13.9
February	26.2	02.6	15.8
March	30.8	07.0	18.6
April	39.8	27.2	13.6
May	42.6	15.1	28.1
June	43.7	21.8	33.6
July	43.6	23.8	32.8
August	40.9	23.4	29.8
September	39.0	16.9	29.1
October	37.6	10.4	25.6
November	32.5	08.0	18.9
December	26.4	02.9	14.6

H = Highest at any point of time in a month
L = Lowest at any point of time in a month
M = Mean temperature

South-west monsoon generally strikes the district of Gurgaon in the first week of July and continues up to the end of August. The average rainfall of the district is about 557mm. During the period of south-west monsoon about 88% rainfall of the year is received. During winters rainfall is scanty and accounts for about 12% of the total rainfall. The following

Table-1.3 provides figures about the mean monthly distribution of rainfall in the district for the year 1993.

TABLE 1.3
DISTRICT GURGAON
MEAN MONTHLY RAINFALL
1993

Months	Rainfall (mm)
January	30.0
February	6.1
March	40.8
April	38.6
May	41.8
June	21.0
July	110.7
August	206.1
September	28.6
October	2.6
November	8.8
December	12.1
District Gurgaon	**557.2**

Table-1.4 shows data of the average rainfall of various rain gauge stations in the district of Gurgoan for a period of twenty years (1974-1993).

The above table shows that maximum rain fall is received at Gurgaon which is followed by Ferozpur Jhirka, Nuh, Punhana, Taoru, Nagina, Sohna, Pataudi and Farrukhnagar.

TABLE 1.4
DISTRICT GURGAON
MEAN ANNUAL RAINFALL
1974-93

Rain Guage Station	Rainfall (mm)	Rainfall Variability (%)
Gurgaon	752.53	40.89
Farrukhnagar	415.61	51.20
Sohna	480.35	35.36
Pataudi	437.92	41.95
Taoru	515.00	43.52
Nuh	560.95	45.34
Nagina	490.63	61.94
Ferozpur Jhirka	673.00	39.47
Punhana	521.04	38.98
District	**529.84**	**33.33**

The natural vegetation found in the district of Gurgaon is tropical thorn type which is associated with semi-arid climatic conditions. In this type of vegetation broad leaved deciduous and thorny bushes are generally widely spaced with heights ranging between 3 to 5 feet make up most of the vegetation. Among the range of xerophytic plants and trees, the common are various species of cactus and accacia. The natural vegetation in the district of Gurgaon is mainly confined to the Aravalli ranges and spurs and its dissected uplands.

DRAINAGE

A good drainage system is necessary in order to strengthen the agricultural base of the area. The district of Gurgaon, however, suffers from the lack of perennial drainage system. The drainage of the district is in the form of a network of seasonal streams and hill torrents and is divided by the Sohna-Delhi Aravalli ranges into two sub-systems namely Western Drainage System and Eastern Drainage System.

Western Drainage System

In this system, Sahibi Nadi is a powerful seasonal stream with its source in the hills of Alwar district of Rajasthan. However, most part of this drainage system lies outside the present territory of the district of Gurgaon. A small portion of the course of Sahibi Nadi passes through the Pataudi block of Gurgaon district before finally it receeds into Rohtak district. Apart from Sahibi Nadi, the western drainage system includes Badshahpur Nala and its tributaries like Bhawaro Nala, Daulati Nadi and Kaunsat Nala, Mahandwari Nala as well as Manaesar Nala. All of them are seasonal streams with significant flow of water from July to August. These tributaries are 6 to 15 metres long and 5 to 7 metres wide. The relative height of their banks varies between 2 to 5 feet.

The Eastern Drainage System

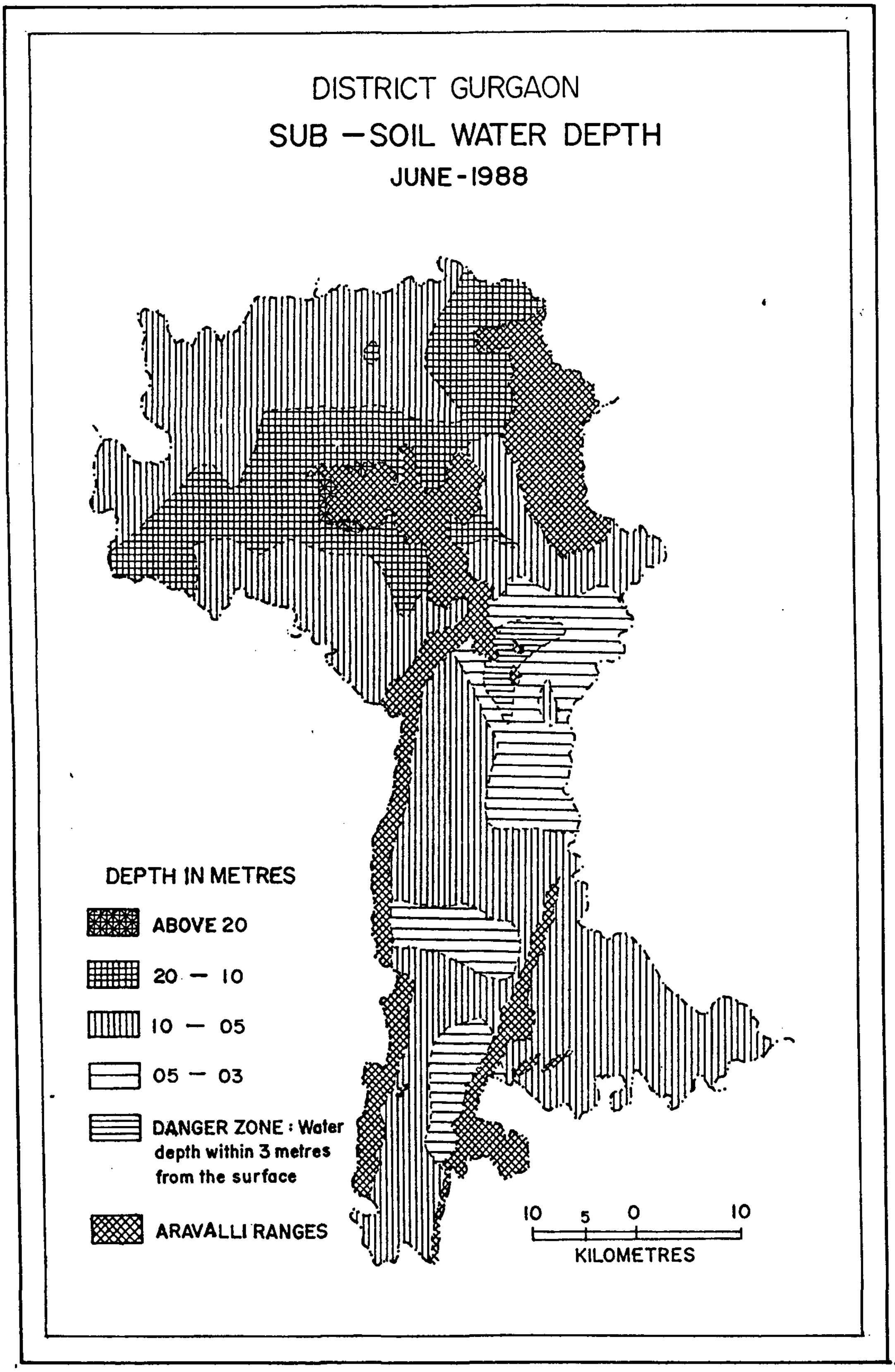
This system comprises of River Yamuna which is a perennial river. The course of this river is completely outside the present territory of the

Gurgaon district, However, the construction of Agra Canal in 1875 has proved to be a great boon to the south eastern part of the district. A number of other distributaries to this canal has increased its command area considerably. The Bhangars of Nuh, and Ferozpur Jhirka are mostly benefited from this canal. The other drainage system includes Landoha Nala, Ujina drain, Chandeni link drain and Nuh main drain. The important lakes in the distict are Sultanpur, Damdama, Ujina, and Kotla.

In the years of good monsoon, Sahibi Nadi and Agra Canal are the main sources of floods. About 52% of the area adjacent to them is inundated. In the north western part, Sahibi and Pataudi are the most affected areas while in the southern parts, Dahar, Bundher and Chaeknote of Ferozpur Jhirka, Bhangar and Dahar of Nuh are severely affected by floods.

HYDROLOGY

In Gurgaon district, the ground water occurs in the zone of saturation within the alluvium while some water is also found in quartzites of Delhi system. The water occurs both under shallow water table conditions and at deeper levels under confined condition (Fig. 1.5). Water table generally follows the topography of the area. The water logging conditions after rains, occur in the north-western and central parts of the district. Geothermal springs are found in and around Sohna.



SOURCE – OJHA, B.S. AND SINGH, J., 1993. RESOURCE PLANNING ATLAS OF SOUTH AND SOUTH WESTERN HARYANA, NATIONAL BOOK ORGANISATION, NEW DELHI.

Fig.I.5

The depth of the water table in Gurgaon district is quite variable.

TABLE 1.5
District Gurgaon
Depth to water table (pre-monsoon period, June 1993)

Block	Area occupied (Sq. kms.) Depth in meters		
	< 10	10-20	> 20
Gurgaon	--	251.39	86.19
Farrukhnagar	22.51	244.82	02.61
Pataudi	--	236.61	42.90
Sohna	140.16	140.16	21.56
Taoru	--	137.39	22.17
Nuh	409.79	011.58	--
Nagina	194.90	021.66	--
Ferozpur Jhirka	188.49	062.32	--
Punhana	241.51	030.53	--
Total **Absolute**	**1197.39**	**1136.46**	**196.23**
Total **Percentage**	**44.5**	**41.5**	**7.0**

Note : 7% rockey outcrop area

Source : Unpulished record, Ground Water Cell. Gurgaon, Haryana

In June 1993, 44.5% (Table-1.5) of the area was in depth to water zone within 10 meters. This area includes entire Mewat region of the district including the hilly region, northern parts of the Farrukhnagar block and eastern part of the Sohna block. About 41.5% of the total geographical area of the district lies under 10-20 meters water table range. About 7% area falls under the water table depth above 20 meters. This is located in Gurgaon block (Dundahera, Gurgaon, Shikohpur, Kasan, Wazirabad and Manesar villages), Pataudi block (Kufferpur) and Taoru block (Chahalka, Silkhoh, Chhajupur, Pipaka) and Sohna block (Badshahpur, Tikli). During the post-monsoon period, the depth to water table zone up to 10 meters increased to 54% of the total geographical area (Table1.6).

TABLE 1.6
District Gurgaon
Depth to water table (Post-monsoon period, October 1993)

Block	Area occupied (Sq. kms.) Depth in meters		
	< 10	10-20	> 20
Gurgaon	044.89	213.68	79.08
Farrukhnagar	125.22	154.77	09.85
Pataudi	--	255.85	23.66
Sohna	186.68	115.00	--
Taoru	007.75	138.49	13.32
Nuh	431.37	--	--
Nagina	200.71	015.88	--
Ferozpur Jhirka	225.89	024.92	--
Punhana	253.49	018.58	--
Total Absolute	**1466.00**	**937.17**	**125.84**
Total Percentage	**54.00**	**34.00**	**5.00**

Note : 7% rockey outcrop area

Source : Unpulished record, Grbund Water Cell. Gurgaon, Haryana

The fluctuation in the water table is of two types : long term on account of agricultural practices like permanent installation of minor irrigation units on large scale development and short term due to rainfall deficiency. It is observed that between June 1982 and June 1993, there is a long term decline in water table which is to the tune of 9.08 metres in Pataudi block and 0.2 meters in Nuh block. These are the extreme values for long term water fluctuation. The reason behind may be higher values for the density of minor irrigation units in Pataudi block (21.0 M.I units/ m^2) and lowest in Nuh and Nagina block (4.0 MI.units/km^2). The short t rm fluctuation of water table is observed during the pre-monsoon and p st-monsoon period and its value depends upon the intensity of m nsoon.

The ground water quality (Fig. 1.6) based upon the observations at dug well points for determining the suitability of ground water for irrig tion purposes is assessed by the Ground Water Cell, Department of Agri ulture, Gurgaon. The criteria for the assessment of the quality of groun l water in given in the following Table-1.7.

TABLE 1.7
District Gurgaon

Assessment of the Quality of Ground Water

Water Quality	Electrical Conductivity (Micro mhos/cm at 25^{0}c*
Fresh/Sweet Water	0 - 2000
Sub-Marginal Water	2001 - 4000
Marginal Water	4001 - 6000
Saline Water	6001 and above

Source : Ground Water Cell, Gurgaon, Haryana

* For salinity values in terms of parts per million multiply electrical Conductivity figures by 0.64.

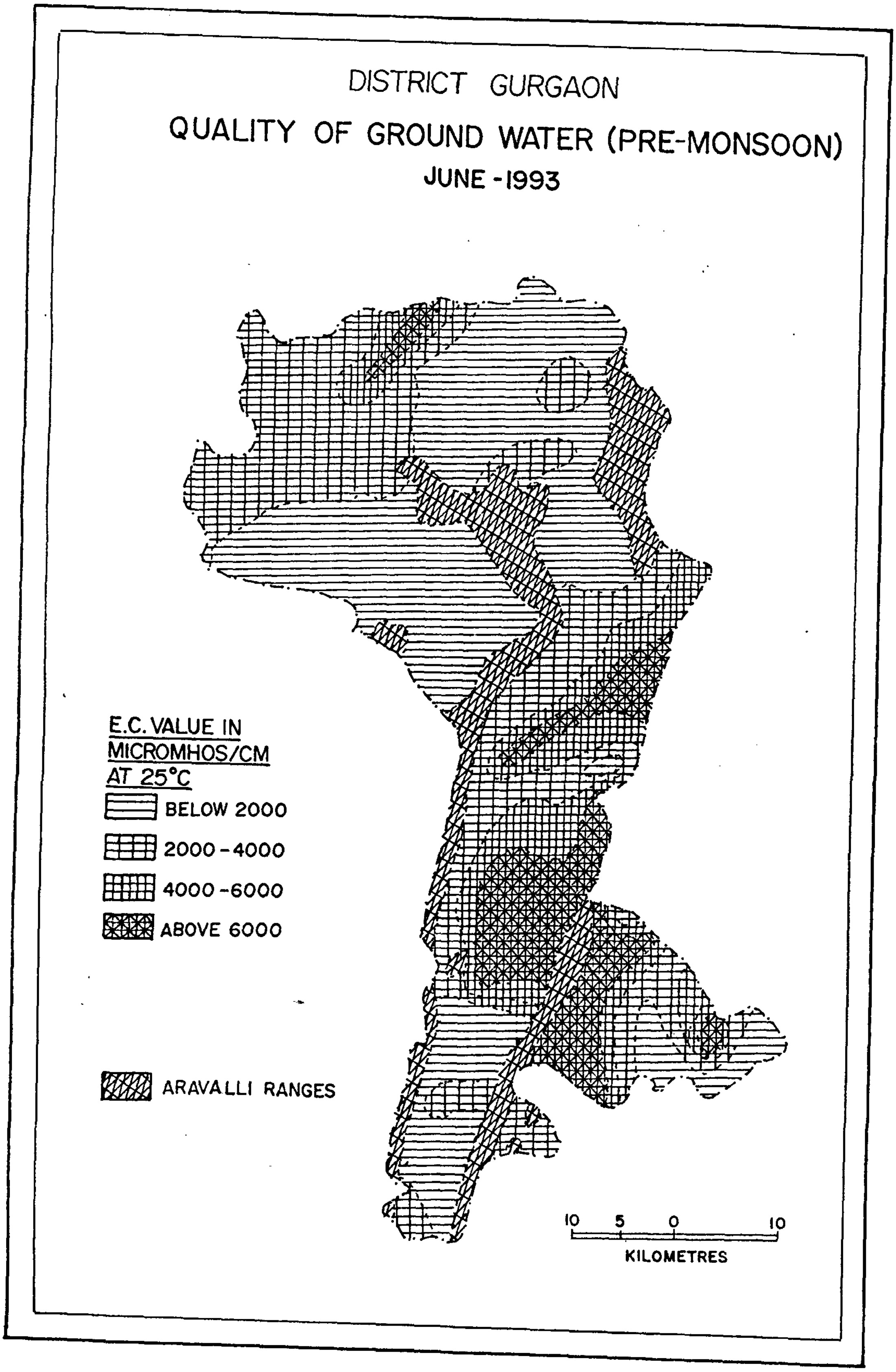

DISTRICT GURGAON
QUALITY OF GROUND WATER (PRE-MONSOON)
JUNE -1993
E.C. VALUE IN
MICROMHOS/CM
AT 25°C
BELOW 2000
2000-4000
4000-6000
ABOVE 6000
ARAVALLI RANGES
10 5 0 10
KILOMETRES

Fig.I.6

According to above mentioned classification, 42% of the geographical area of the district falls under fresh water zone (June 1993). The sub-marginal to marginal water zone area of 37% as worked out for the same period is also suitable for agricultural purposes and can be used for irrigation with little water management practises. 14% of the area of the district falls under saline water zone which is quite unsuitable for irrigation purposes (Table-1.8).

TABLE 1.8
District Gurgaon
Qualiy of Ground Water
Pre-monsoon Period, June 1993
(Area in Sq. Kms.)

Block	**Quality of Water (EC)**			
	Up to 2000 Fresh	**2001-4000 Sub-Marginal**	**4001-600 Marginal**	**6000 and above Saline**
Gurgaon	283.70	44.90	8.98	--
Farrukhnagar	39.40	216.67	23.92	9.85
Pataudi	199.65	79.86	--	--
Sohna	174.30	73.67	46.72	7.19
Taoru	158.44	--	1.12	--
Nuh	62.26	134.67	104.26	120.18
Nagina	14.44	44.77	49.09	108.29
Ferozpur Jhirka	152.66	77.91	12.46	7.78
Punhana	59.71	38.50	38.48	135.35
Total	**1144.45**	**710.95**	**285.03**	**388.64**
Percentage	**42**	**26**	**11**	**14**

EC : Electrical Conductivity

Note : 7% is the out crop area

Source : Ground Water Cell, Gurgaon, Haryana

During the post-monsoon period (October, 1993) the area under fresh water zone was 54% and that under sub-marginal to marginal water zone was 34% of the total area of the district. Saline water is found in all blocks of Gurgaon district except in blocks of Gurgaon, Farrukhnagar, Pataudi and Taoru (Fig. 1.7). The concentration of saline water is more in Nuh, Sohna, Nagina and Punhana blocks. It occupies 5% of the area of the district (Table 1.9)

TABLE 1.9
District Gurgaon
Qualiy of Ground Water
Post-monsoon Period, October 1993
(Area in Sq. Kms.)

Block	**Quality of Water (EC)**			
	Up to 2000 Fresh	**2001-4000 Sub-Marginal**	**4001-600 Marginal**	**6000 and above Saline**
Gurgaon	265.75	64.65	7.18	--
Farrukhnagar	195.57	87.24	7.03	--
Pataudi	251.42	28.09	--	--
Sohna	185.08	68.28	12.58	35.94
Taoru	158.45	1.11	--	--
Nuh	101.36	165.08	105.70	49.23
Nagina	64.99	98.18	23.10	30.32
Ferozpur Jhirka	168.24	63.87	4.67	14.03
Punhana	70.33	130.05	49.10	22.56
Total	**1461.19**	**706.55**	**209.36**	**157.08**
Percentage	**54**	**26**	**8**	**5**

Note : 7% is the out crop area

Source : Ground Water Cell, Gurgaon, Haryana

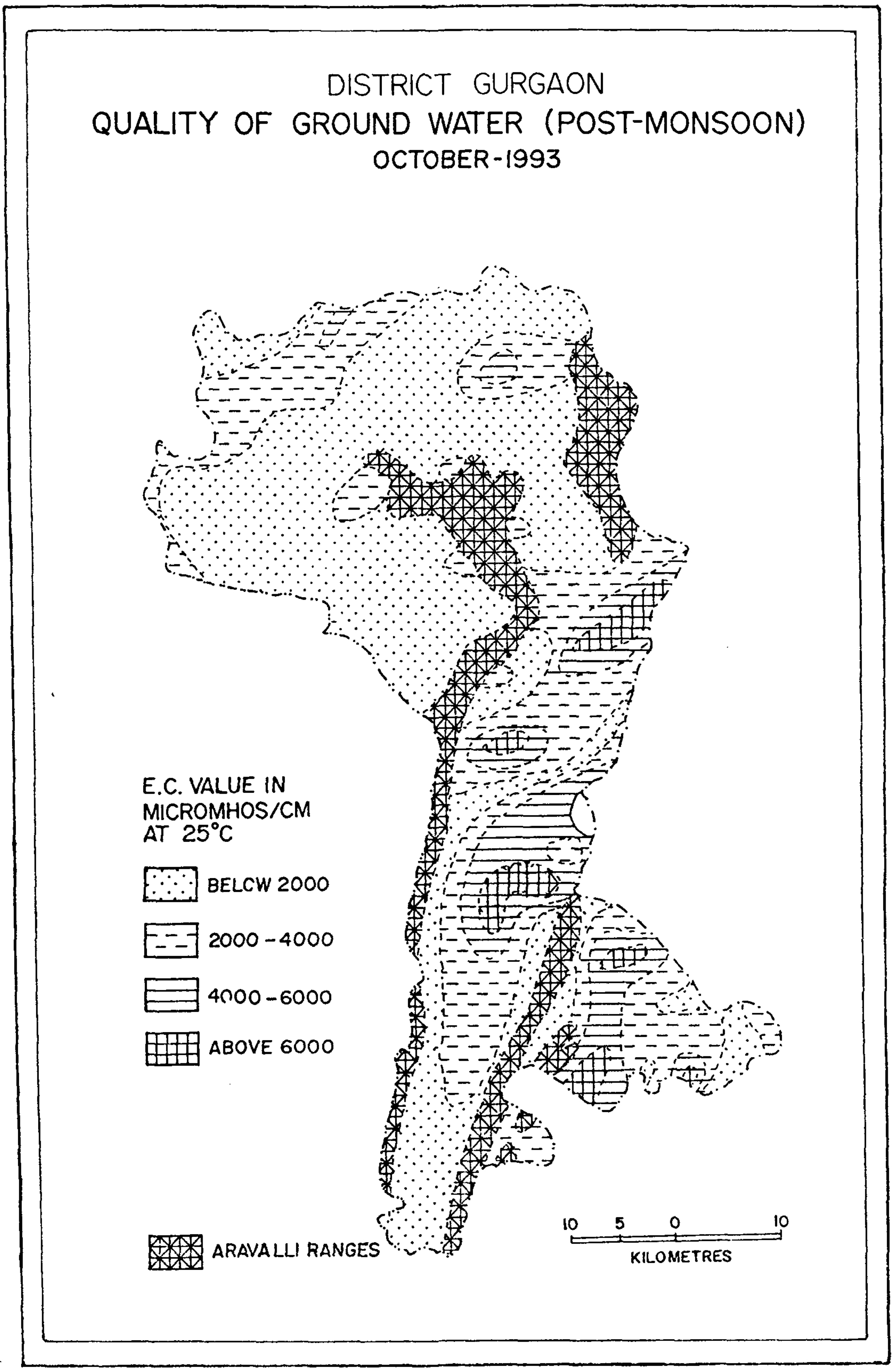

DISTRICT GURGAON
QUALITY OF GROUND WATER (POST-MONSOON)
OCTOBER-1993
E.C. VALUE IN
MICROMHOS/CM
AT 25°C
BELCW 2000
2000 - 4000
4000 - 6000
ABOVE 6000
ARAVALLI RANGES
10 5 0 10
KILOMETRES

Fig.I.7

Pedology

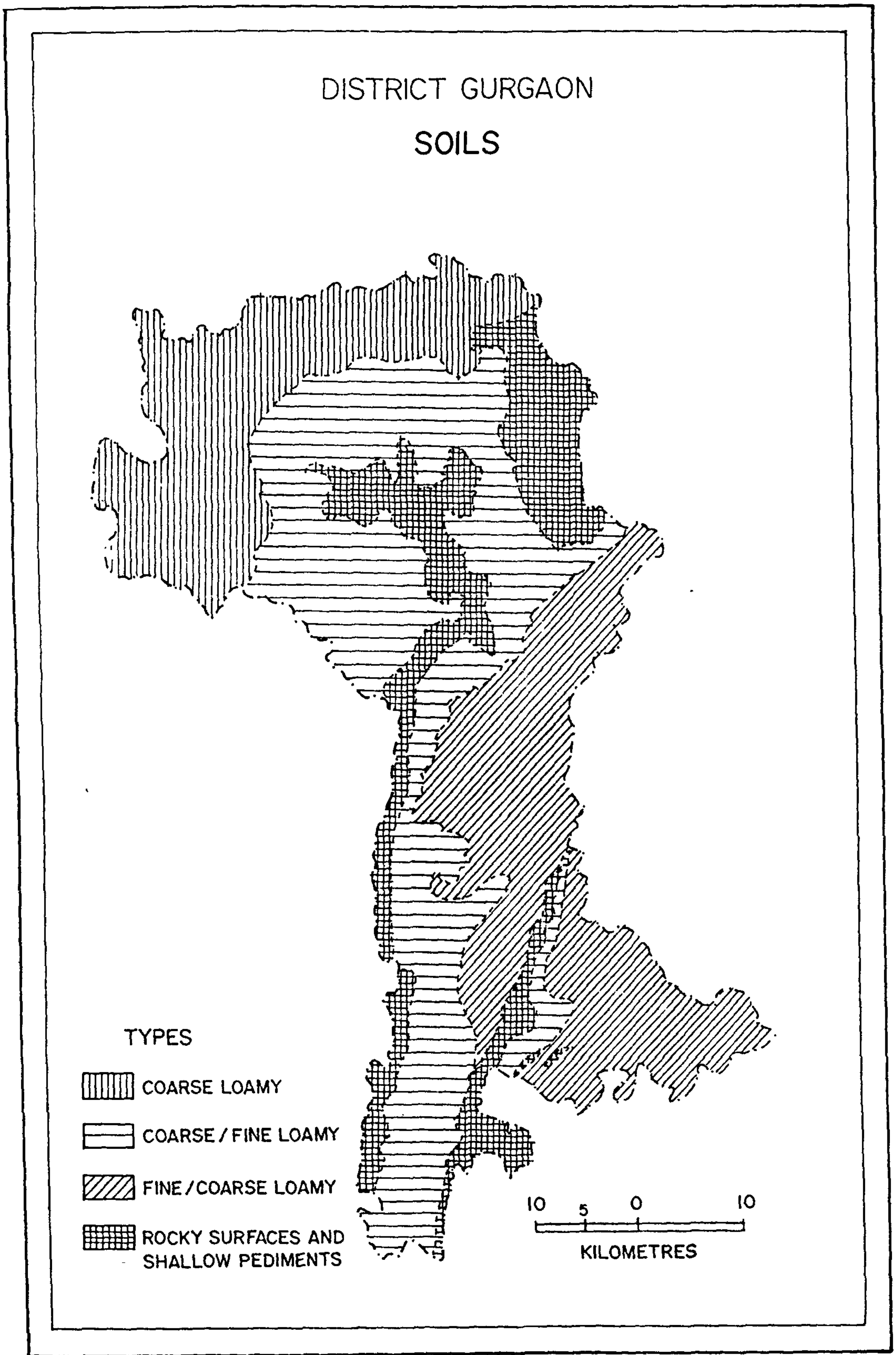
Soil are the natural assets for a country like India where about 65% of GDP is based upon agriculture. A proper combination of texture, structure and both organic as well as inorganic components of soils yield a good crop production. In Haryana, old alluvial, riverine, aeolian, non-saline and non-calcareous soils are found. However, the soils in the district of Gurgaon are generally coarse loamy, coarse/fine loamy, fine/ coarse loamy, and rocky surfaces and shallow pediments (Fig. 1.8). These soils range between 7.5-8.5 on pH scale, and have phosphorous contents varying between 309-1235 pounds per acre.

Coarse Loamy Soils

With a clay content ranging from 15% to 18% and the proportion of sand above 15% are one of the fertile soils of Gurgaon district.This soils is distributed over the whole of Pataudi tehsil and extends in the form of a 6-12 kilometer wide belt along the northern border of Gurgaon tehsil. These soils are highly granular and porous, and have a crumb structure which is considered most useful for plant growth. These soils need intensive irrigation for being cultivated in rainfall deficient areas. Wheat, mustard and dry farming crops are grown on these soils.

Coarse / Fine Loamy Soils

Coarse loamy soils intermixed with fine loamy soils are found around Aravalli ranges and dissected uplands. These soils are found over



SOURCE - OJHA, B.S. AND SINGH, J., 1993. RESOURCE PLANNING ATLAS OF SOUTH AND SOUTH WESTERN HARYANA, NATIONAL BOOK ORGANISATION, NEW DELHI.

Fig.I.8

a vast area covering the whole of Taoru Upland, remaining portion of Gurgaon tehsil except a small patch in the extreme south-eastern part of it, a narrow belt stretching in north-south direction along the Aravalli range in Nuh and Ferozpur Jhirka tehsils. This belt covers a major portion of the Inter-Aravalli Basin. A narrow north-south belt of these soils is also found along the eastern flank of Aravalli range in Punhana block of Ferozpur Jhirka tehsil.

These soils are dominated by coarse loam and are interspersed with patches of fine loam. With assured water supply either through irrigation or rainfall these soils are capable of growing wheat, mustard,gram, pulses, vegetables and other crops.

Fine/coarse Loamy Soils

Fine loamy soils which are intermixed with coarse loamy soils are the soils of old alluvial plains and new alluvial plains of the district. These soils are found in the form of a small patch in the south eastern part of Gurgaon tehsil, the whole of the eastern part of Nuh tehsil, the north-eastern part of Inter-Aravalli Basin and almost the whole of Punhana block of Ferozpur-Jhirka tehsil. These soils are highly fertile except where they are adversely affected by salinity. On account of dry conditions excessive evapo-transpiration and constant soil moisture deficit at places these soils are loose in texture and are found in the form of sandy loam and silty loam soils (coarse loamy soils). While at other places they are compact due to intensive irrigation. Therefore, these soils vary from sandy clay loam to clay loam and silty clay loam (fine loamy soils) in irrigated soil environment. These soils are capable of producing a variety of crops like wheat, paddy sugarcane, gram, pulses and oil seeds.

Rocky Surface and Shallow Pediments

This type of soil is coarse, with thin horizons and are not very fertile. The area of occurrence of this type of soils are the Aravalli ranges and their dissected uplands. Some parts of Aravallies are completely devoid of soil cover and are bare rocky surfaces. However, these types of soils and shallow pediments can be used for social foresty.

HUMAN RESOURCE BASE

There are 688 inhabited and 42 uninhabited villages in the district of Gurgaon with a total population of 9,13,386 persons (Census of India, 1991). The district Gurgoan is predominantly a rural area as only 20.30% of its population is urban and 79.70% is rural . The total rural population is 9,13,386 persons. The different blocks of the district show varying population distribution patterns (Table -1.10). Nagina with 100 % rural population is followed by Nuh which has the second highest percentage of rural population (94.79%). Nuh is followed by Punhana (93.51%), Farrukhnagar (91.13%), Ferozpur Jhirka (88.14%), Taoru (85.74%), Sohna (84.53%), and Pataudi (79.95%). Gurgoan block has the lowest figure of only 49.31% for rural population.

TABLE 1.10
District Gurgaon
Density and distribution of Population
1991

Block	**Population**			**Density of Rural Population**
	Total	**Rural (%)**	**Urban (%)**	**(Persons/Km^2)**
Gurgaon	2,84,212	49.81	50.19	438
Farrukhnagar	90,756	91.13	8.87	302
Pataudi	1,22,426	79.95	20.05	422
Sohna	1,05,690	84.53	15.47	291
Taoru	87,869	85.74	14.26	347
Nuh	1,43,884	94.79	5.21	301
Nagina	1,72,824	100.00	0.00	338
Ferozpur Jhirka	1,04,662	88.14	11.86	290
Punhana	1,33,767	93.51	6.49	492
District	**11,46,090**	**79.70**	**20.30**	**352**

Source : Census of India, 1991.

Urban population percentage is not very high. Only 20.30% of the district's population is urban with an actual population figure of 2,32,704 persons. The various blocks show a consistently low percentage of urban population except Gurgoan which records 50.19% of its population as urban. Only Pataudi with 20.05% of its population as urban comes next. Other blocks being dominantly agricultural areas, record very low percentage of urban population ranging from 15.47% in Sohna, 14.26% in Taoru and 5.21% in Nuh. On the scene of total population, however, Gurgoan records highest absolute population both in rural (141,561 persons) and urban (142,651 persons) categories. Nagina with 72,824 persons as rural is solely a rural area.

The density of rural population calculated for every hundred hectares of land for the district as a whole is worked out to be 352 persons. It ranges between 290 and 492 among the nine community development blocks of the district. The maximum density is 492 persons for Punhana block and the minimum is 290 for Ferozpur Jhirka block (Table-1.10).

The blocks having rural population density higher than the district average are Punhana (492), Gurgaon (438), and Pataudi (422); while rest of the blocks of Farrukhnagar (302), Sohna (291), Taoru (347), Nuh (301), Nagina (338) and Ferozpur Jhirka (290) are below the district average.

The rural sex-ratio in terms of number of families per thousand males for the district as a whole is 867. There are only three blocks Punhana (863), Sohna (836), and Gurgaon (836) which are below the figure of district average. The maximum sex-ratio in favour of females is 885 for the block of Nagina, and minimum in favour of families is 836 for the block of Gurgaon (Table-1.11)

TABLE 1.11
District Gurgaon
Rural sex-ratio (No. of females/,000 males)
1991

Block	Sex-ratio
Gurgaon	836
Farrukhnagar	883
Pataudi	879
Sohna	861
Taoru	875
Nuh	869
Nagina	885
Ferozpur Jhirka	875
Punhana	863
District	**867**

Source : Census of India, 1991.

The study of literacy levels Table-1.12 for rural population reveals a hard fact that all the five blocks of Taoru, Nuh, Nagina, Puhana, and Ferozpur Jhirka which have a dominant muslim population of Meo community, are far below the respective district average as far as literacy of total population or its break up in terms of literacy of males and literacy of females is concerned.

TABLE 1.12
District Gurgaon
Literacy in percentage (excluding children in 0-6 age group)
1991

Blocks	Rural			Urban		
	Persons	Males	Females	Persons	Males	Females
Gurgaon	66.66	80.79	48.46	77.70	87.73	65.60
Farrukhnagar	69.89	79.25	44.29	65.88	80.35	49.25
Pataudi	62.37	80.04	42.26	65.51	78.62	50.84
Sohna	58.25	75.71	37.90	67.10	77.94	54.88
Taoru	41.83	60.39	20.22	75.19	86.75	61.74
Nuh	33.61	51.91	12.43	65.49	77.49	51.25
Nagina	29.39	47.84	8.31	--	--	--
Ferozpur Jhirka	26.39	42.34	7.89	61.39	74.49	46.60
Purhana	25.68	43.07	5.14	62.13	75.89	46.51
District	**46.00**	**63.07**	**26.12**	**67.55**	**79.91**	**53.33**

Source : Census of India, 1991

The average literacy of the district of Gurgaon for total rural population is 46 percent. The blocks above this district average are Farrukhnagar (69.25%), Gurgaon (66.16%), Pataudi (62.37%) and Sohna (58.25%). The rest of the blocks are well below the district average. The average rural literacy figures for the total male population of the district is 63.07%. The blocks which have population well above this district average are Gurgaon (80.79%), Pataudi (80.04%), Farrukhnagar (79.25%),and Sohna (75.71%). The remaining blocks of Taoru, Nuh, Nagina, Punhana and Ferozpur Jhirka are below the district average. In case of female literacy the blocks above the district average of 26.12% are Gurgaon (48.46%)., Farrukhnagar (44.29%), Pataudi (42.26%) and Sohna (37.90%). The rest of the blocks are far below the district average. The minimum female literacy is found in Punhana block (5.14%), which is followed by Ferozpur Jhirka (7.89%), Nagina (8.31%), Nuh (12.43%), and Taoru (20.22%).

The blockwise distribution of urban literate population as percentage of total population, male and female population also reveals the same pattern of distribution, through, it is not as significant as in the case of rural literate population (Table-1.12). The blocks of Nuh, Punhana and Ferozpur Jhirka, show invariably much lower percentage of literacy when compared with the district averages of respectivee categories. Pataudi block from the northern part of the district also lags behind in terms of all the three fronts - total literacy, male literacy and female literacy. In Farrukhragar block total literacy (65.88%) and female literacy (49.25%) are below their respective district averages of 67.55% and 53.33% respectively. Male literacy in urban Farrukhnagar (80.35%) is above its respective district average of 79.91%. Gurgaon and Taoru blocks are above the district averages while Sohna shows a decline in literacy except in the category of females (54.88%) which is at a higher side as compared to the corresponding district average of 53.33%.

The rural work participation rates are shown as percentages to total population for main and marginal categories of workers as well as their breakeup into male female categories (Table 1.13).

TABLE 1.13
District Gurgaon
Rural Workers in percentage
1991

Blocks	Main			Marginal		
	Persons	Males	Females	Persons	Males	Females
Gurgaon	27.20	46.44	04.17	01.62	00.20	03.33
Farrukhnagar	27.04	44.89	06.73	02.01	00.11	04.15
Pataudi	26.23	45.21	04.64	01.89	00.34	03.65
Sohna	27.40	44.68	07.33	02.30	00.16	04.79
Taoru	28.97	46.15	09.33	08.04	00.45	16.72
Nuh	28.83	46.98	07.95	12.88	00.74	26.84
Nagina	27.99	45.21	08.55	08.98	00.56	18.48
Ferozpur Jhirka	27.76	46.58	06.26	05.17	00.17	10.88
Purhana	28.16	46.70	06.69	04.78	00.25	10.03
District	**27.74**	**46.01**	**06.67**	**05.34**	**00.34**	**11.11**

Source : Census of India,1991

The share of total main workers for the district of Gurgaon as a whole is 27.74%. This is a category of workers defined by Census of India in which workers are actively engaged all the year round. The low percentage of gainfully employed population in rural areas suggests a degree of dependency of juvenile and senile age groups to the category of actively engaged population. The other reasons may be less employment avenues and environmental restraints. However, the distribution of main workers is not highly variable among the blocks of Gurgaon district. It ranges from 26.23% for Pataudi to 28.97% for Taoru.

A trend in favour of the male employment is noticed. There are 46%, of of main male workers as compared to only 6.67% female workers. The male employment figure also records an almost a consistent distribution which ranges between 14.68% for Sohna to 46.98% for Nuh. All the remaining blocks of Gurgoan lie between 45% to 46%. For the district as a whole, the female work participation figures reveal that there exists a delicate work participation rate of only 6.67% of females as main workers. Compared to the district average, Taoru 9.33%, and Gurgaon block with 4.17% provide the range of female work participation as main worker at block level in the district of Gurgaon.

The marginal workers as defined by the Census of India, are those workers who work for less than 183 days in a year, represented by 5.34% in the distrcit of Gurgaon as a whole. Block wise distribution of these total marginal workers lies between 12.88% for block Nuh and 1.98% for the block of Pataudi. The blocks of Taoru, Nuh and Nagina exhibit a relatively higher concentration of total marginal workers, consequently a grim picture of seasonal unemployment. The percentage of male marginal workers to total rural male population is only 0.34% in the district of Gurgaon. Its blockwise distributional pattern states that it is highest in Nuh (0.74%) and lowest is 0.11% in Farrukhnagar. The other blocks which show a high percentage share of male marginal workers, higher than the district average, are Taoru with 0.45% and Nagina with 0.56% of male marginal workers. A very interesting character of the agricultural employment structure is shown by a considerably high figure of female marginal workers as 11.1% as in Gurgaon district as a whole. This percentage share is highest in Nuh (26.84%) and lowest 3.33% in the block of Gurgaon. The other blocks in which percentage share of female marginal workers is above the respective district everage are Taoru with 16.72% and Nagina with 18.48% of female marginal workers. The blocks of Punhana (10.03%) and Ferozpur Jhirka (10.88%) are very near to the district average of female marginal workers.

It can, well be concluded that as far as the distribution of rural marginal workers is concerned, the blocks of Taoru, Nuh, Nagina, Punhana and Ferozpur Jhirka represent a higher percentage share either near equal to district average or higher than that in all of the three-total, male and female marginal workers categories. The remaining blocks of Pataudi, Farrukhnagar, Gurgaon and Sohna are in a comfortable position since their percentage share of marginal workers is far below the district average figures in all the three categories of total, male and female marginal workers.

IRRIGATION SYSTEMS

Agriculture, the main economic activity of rural India, greatly depends upon the availability of assured water supply for irrigation. The neccessity of assured irrigation becomes acute when arid and semi-arid conditions are at large. So is the case of Gurgaon district which enjoys a semi-arid climate with summer temperature soaring to 45^{0}C in the face of average annual rainfall of 52.9 centimetres. Throny trees and bushes and xerophytic plants are the witness of prevailing aridity in the district.

In Gurgaon district of Haryana on irrigation front, tube-wells have stolen the show and are responsible for improved intensity of irrigation. The role of canals in irrigation systems of the district has been a subdued one with its share of only about 1.1%.

The history of ground water exploration in Gurgaon district dates back to 1954 when Exploratory Tube-well Organisation of Goverment of India took up extensive exploratory drilling under "All India Exploration Programe". This organisation, now is called as Central Ground Water

Board, had drilled 34 test bores till 1993, out of which 14 bore-holes were declared abondoned due to inadequate thickness of granular zones and poor water quality. In addition 25 bore-holes were put in by HSMITC out of which 9 bore-holes were successful and remaining were abondoned.

The ground water development in the private sector was encouraged with the foundation of Haryane State in 1966 through institutional credit Small Farmer Development Agenecy (SFDA) and Agriculture Reinforcement Development Corporation/National Bank of Agriculture and Rural Development (ARDC/NABARD) programme. In addition, farmers have installed their tube-wells in large numbers from their own resources. The blockwise current status of tube-wells is given below in Table 1.14.

TABLE 1.14
District Gurgaon
Number of Minor Irrigation Units
1993

Block	Tube-wells	Pumping Sets	Wells	Total	Density (Units/Km^2)
Gurgaon	5216	19	--	5235	15
Farrukhnagar	6138	--	--	6138	21
Pataudi	5743	--	--	5743	21
Sohna	3954	157	--	4103	13
Taoru	3921	12	--	3933	20
Nuh	2004	55	7	2066	05
Nagina	707	176	--	883	04
Ferozpur Jhirka	1600	353	--	1953	06
Punhana	3212	45	--	3257	12
District	**32487**	**817**	**7**	**33304**	**12**

Source : Hydrologist, Department of minor irrigation, District Gurgaon, Haryana

The main sources of irrigation in the district of Gurgaon are tube-wells and Gurgaon-Agra Canal. The net irrigated area is 5860.46 hectares of land which amounts to 54.81% of the net sown area. With respect to this distict average only four blocks namely Pataudi (88.25%), Farrukhnagar (84.76%), Taoru (73.78%), and Gurgaon (72.46%) are well above it. Two of the blocks namely Sohna (53.29%) and Punhana (53.28%) are very close to the district average irrigated area. The remaining blocks of Nuh (29.85%), Ferozpur Jhirka (25.51%) and Nagina (12.17%) are far below the figure of the distirct average of irrigated area.

The block wise study of the source wise irrigation (Table 1.15) reveals that in Pataudi 93.24% of the total irrigated area is irrigated by tube-wells, the remaining 6.76% in irrigated by wells. This block has 5743 minor irrigation units and their density is 21 per square kilometer.

TABLE 1.15
District Gurgaon
Area Irrigated by source in percentage
1991

Block	Irrigated Area to Net Area Sown	Government Canal	Wells	Tube-wells	Total
Gurgaon	72.46	0.28	12.45	87.27	100.00
Farrukhnagar	84.76	--	08.24	91.76	100.00
Pataudi	88.25	--	06.76	93.24	100.00
Sohna	53.29	7.65	11.82	80.17	100.00
Taoru	73.78	--	02.16	97.84	100.00
Nuh	29.85	59.75	00.78	39.47	100.00
Nagina	12.17	10.82	04.35	84.83	100.00
Ferozpur Jhirka	25.51	--	19.94	80.06	100.00
Punhana	53.28	21.29	00.15	77.30	100.00
District	**54.81**	**11.09**	**07.41**	**81.40**	**100.00**

Source : District Census Handbook-Gurgaon, Census of India, 1991

In Farrukhnagar, a major part of the total irrigated area is irrigated by tube-wells which is about 91.76%. The remaining 8.24% irrigated area is irrigated by wells. In this block total minor irrigation units are 6138 with a density of 21 per square kilometer.

The block of Taoru where 97.84% of the total irrigated area is irrigated by tube-wells, the remaining 2.16% is irrigated by wells. In this block, the total number of minor irrigation units are 3933 with a density of 20 per square kilometer.

In Gurgaon block, 87.27% of the total irrigated area is irrigated by tube-wells, while 12.45% by wells and the remaining 0.28% is irrigated by Gurgaon Canal. In this block the total number of minor irrigation units are 5235 with a density of 15 per square kilometer.

In Sohna block, the percentage of total irrigated area by tube-wells is 80.17%, while 11.82% and 7.65% of the total irrigated area is irrigated by wells and goverment canal respectively. The total number of minor irrigation units for this block are 4103 with a density of 13 per square kilometer.

In Punhana block, 77.3% area is irrigated by tube-wells while 21.29% is irrigated by goverment canal and 0.15% by wells. The total number of minor irrigation units in this block are 3257 with a density of 12 per square kilometer.

In Nuh block, major portion of the irrigated area (59.75%) is irrigated by canal. It is the only block of Gurgaon district where canal irrigation is dominant. The main distributaries are Ujina drain Chandeni

Link drain and Nuh main drain. The other sources of irrigation are tube-wells (39.47%) and wells (0.78%). The total number of minor irrigation units within this block is 2059 with a density of 5 per square kilometer.

In Ferozpur Jhirka block, 80.06% of the area is irrigated by tube-wells. While 19.94% is irrigated by wells and there is no canal irrigation in this block. The total number of minor irrigation units in this block are 1953 with a density of 6 per square kilometer.

Nagina block, where the percentage of irrigated area to the net sown area is minimum (12.17%), 84.83% of the total irrigated area is irrigated by tube-wells and the remaining 19.94% is irrigated by wells. In this block, the total number of minor irrigation units are 1953 with a density of 6 per square kilometer.

From the above description, it is evident that in Gurgaon district the sub-soil water resouces are exploited to a maximum limit for irrigation purposes. The tube-wells and wells together with accounts for about 88.81% of the total irrigated area, while canal accounts only for about 11.09% of the total irrigated area of the district. Hence, it can be argued that tube-well irrigation is highly instrumental in shaping the agricultural landscape of the district of Gurgaon.

THE AGRICULTURAL PROFILE

The district of Grugaon presents basically an aggrarian economy. The total area of the district being 2,75,014 hectares of land, out of which 2.57% is classified as uncultivable waste, 15.08% as area not available for agriculture, 0.59% area devoted to pastures, 3.35% to the forests, 14.67% is designated as current fallow, and the remaining 63.74% of the area is net area sown with a cropping intensity of 53.48% for the agricultural calender year of 1993-94. The general agricultural landuse at tehsil level is shown in Table-1.16.

TABLE 1.16
District Gurgaon
General Agricultural Landuse at Tehsil Level
Area in Hectares/(percentage)
1992-93

Landuse	Gurgaon	Pataudi	Nuh	F.P. Jhirka	Total
Uncultivable Waste	2652 (2.6)	316 (1.39)	2767 (4.02)	1338 (1.64)	7073 (2.57)
Area not Available for Agriculture	18239 (17.90)	412 (1.81)	9341 (13.56)	13469 (16.54)	41461 (15.08)
Pastures	992 (0.97)	58 (0.25)	235 (0.34)	331 (0.41)	1616 (0.59)
Forest	3535 (3.47)	-- --	4326 (6.28)	1348 (1.66)	9209 (3.35)
Current Fallow	8561 (8.40)	5998 (26.32)	12112 (17.58)	13682 (16.81)	40353 (14.67)
Net Sown Area	67923 (66.66)	16008 (70.24)	40123 (58.23)	51248 (62.95)	175302 (63.74)
Double Cropped Area	19574 (28.82)	7634 (47.69)	30075 (74.96)	36470 (71.16)	93753 (53.48)
District	**101902 (100.00)**	**22792 (100.00)**	**68904 (100.00)**	**81416 (100.00)**	**275014 (100.00)**

Source : Agricultural Landuse Report 1992-93, Department of Agriculture, District Gurgaon, Haryana

The Gurgaon tehsil with a geographical area of 1,01,902 hectares of land shows a break up of agricultural landuse into uncultivable waste (2.6%), area not available for agriculture (17.90%), pastures (0.97%), forest cover (3.47%), current fallow (8.40%) , and net area sown (66.66%) along with a cropping intensity of 28.82%. The current fallow which amounts to 8.4% of the total geographical area of the tehsil is far below the district average of 14.67% for the same categories of landuse. However, in case of the intensity of cropping (28.82%) tehsil Gurgaon is far below the respective district average of 53.48%.

The Tehsil Pataudi with a geographical area of 22,792 hectares is categorised into uncultivable waste land (1.39%), area not available for agriculture (1.81%), pasture land (0.25%), forest (0.0%), current fallow (26.32%), and net area sown (70.24%). The double cropped area for Pataudi is 47.69 percent.

The landuse classes in Pataudi tehsil which are lying below the respective district averages are uncultivable waste, area not available for agriculture, pasture lands, and forest cover. The forest cover is absent in the tehsil of Pataudi as against the district average of 3.35 percent.The percentage of double cropped area (28.82) is also far below the respective district average of 53.48 percent.

The general agricultural landuse scenario of Nuh tehsil is that out of the total geographical area of 68,904 hectares of land, uncultivable waste accounts for about 4.02%, area not available for agriculture for about 13.56%, pastures being 0.34%, forest cover accounts for about 6.28%, the current fallow equals to 17.58%, and the net area sown is recorded as 58.23 percent. The double cropped area is farily high

(74.96%) as compared to the respective district average of 53.48%. The forest cover in Nuh tehsil is also approximately two times the respective district average.

The Ferozpur Jhirka tehsil with a geographical area of 81,416 hectares of land shows of 1.64% of uncultivable waste land, 16.54% of the area as not available for agriculture, 0.41% of pastures, 1.66% of forest cover, 16.71% of current fallow, 62.95% of net area sown, along with 71.16% of cropping intensity. In this tehsil forest cover is far below (1.66%) the district average (3.35%). However, cropping intensity (71.16%) is fairly high as compared to the district average of 53.48 percent.

The statistics of crop distribution at tehsil level, shows that cereals predominate both in Rabi and Kharif seasons. During Rabi season of 1993-94 cereal crops including paddy, wheat, gram and barley occupied 63.82% of the total cropped area of the district. The respective percentages for these cereals in the tehsils of Gurgaon, Pataudi, Nuh and Ferozpur Jhirka are 72.35%, 72.01%, 63.52% and 54.21% respectively. The second most important crop group is that of oil seeds which includes the crops like, mustard, rape seed and grounnut etc. Oil seeds occupy 31.89% of the total cropped area of Rabi cropping season of the district. Respective positions of the tehsils of Gurgaon, Pataudi, Nuh, and Ferozpur Jhirka are 21.91%, 18.07%, 33.14% and 43.47%. After cereals and oil seeds in Rabi season, the third important crop group is that of pulses which occupy 1.17% cultivated area of the district as a whole. The tehsil-wise distribution of pulses is 1.37% for the tehsil of Gurgaon, 0.56% for Pataudi,1.38% for Nuh, and 0.98% for the tehsil of Ferozpur Jhirka. Following pulses during Rabi cropping season other important crops/crop groups in the district of Gurgaon are vegetables (0.87%), spices like coriander and red chile (0.85%), sugarcane (0.31%), cotton (0.05%) and others. The distribution of these crops/crop groups is given in Table-1.17.

TABLE 1.17
District Gurgaon
Kharif Crops/Crop Groups at Tehsil Level
Area in Hectares/(percentage)
1992-93

Crops	Gurgaon	Pataudi	Nuh	F.P. Jhirka	Total
Jowar	1698 (5.01)	17 (0.21)	5872 (26.53)	8947 (37.08)	16534 (18.72)
Bajra	26475 (78.18)	6837 (83.54)	13479 (60.90)	12901 (53.47)	59692 (67.59)
Barley	4265 (12.59)	1175 (14.36)	2459 (11.11)	1356 (5.62)	9255 (10.48)
Maize	13 (0.04)	-- --	3 (0.01)	-- --	16 (0.02)
Fruits	86 (0.25)	-- --	3 (0.01)	-- --	89 (0.10)
Vegetables	1169 (3.45)	42 (0.51)	172 (0.78)	600 (2.49)	1983 (2.25)
Fenugreek	19 (0.06)	21 (0.26)	6 (0.03)	1 (0.004)	47 (0.05)
Dill	-- --	01 (0.01)	-- --	-- --	01 (0.001)
Oil Seeds	139 (0.41)	91 (1.11)	139 (0.63)	324 (1.34)	693 (0.78)
Total Kharif	**33864** **(100.00)**	**8184** **(100.00)**	**22133** **(100.00)**	**24128** **(100.00)**	**88310** **(100.00)**

Source : Agricultural Landuse Report 1992-93, Department of Agriculture, District Gurgaon, Haryana

During the Kharif season of 1993-94 the distributional pattern of various crops/crop groups shows that cereals occupy the largest percentage share, which accounts for about 96.71% of the cultivated area of the district during the Kharif season. Out of it 67.95% is occupied by Bajra, 18.72% by Jowar, and 0.02% by maize. Second important crop group is that of vegetables which occupy 2.25% of the total cultivated area. Vegetables are followed by oil seeds (0.78%), fenugreek (0.05%), and dill (0.001%). The respective share of these crops at tehsil level is provided in Table-1.18.

TABLE 1.18
District Gurgaon
Rabi Crops/Crop Groups at Tehsil Level
Area in Hectares/(percentage)
1992-93

Crops	Gurgaon	Pataudi	Nuh	F.P. Jhirka	Total
Cereals	37795 (72.35)	10912 (72.01)	29943 (63.52)	31448 (54.21)	110098 63.82
Pulses	715 (1.37)	85 (0.56)	652 (1.38)	570 (0.98)	2022 (1.17)
Sugarcane	56 (0.11)	7 (0.05)	145 (0.31)	319 (0.55)	527 (0.31)
Vegetables	698 (1.34)	166 (1.10)	249 (0.53)	381 (0.66)	1494 (0.87)
Spices	405 (0.78)	950 (6.27)	118 (0.25)	01 (0.00)	1474 (0.85)
Cotton	12 (0.02)	2 (0.01)	25 (0.05)	44 (0.08)	83 (0.05)
Jute	37 (0.07)	-- --	9 (0.02)	14 (0.02)	60 (0.03)
Oilseeds	11442 (21.91)	2738 (18.07)	15621 (33.14)	25219 (43.47)	55020 (31.98)
Total Rabi	**52234** **(100.00)**	**15153** **(100.00)**	**47136** **(100.00)**	**58004** **(100.00)**	**172507** **(100.00)**

Source : Agricultural Landuse Report 1992-93, Department of Agriculture, District Gurgaon, Haryana

Like other parts of Haryana, the distirct of Gurgaon has also experienced large scale mechanization. As per the data provided for the year 1992 by the Department of Agriculture, Gurgaon, a tehsil level study about the distribution of existing agricultural implements and mechinery was carried out. All agricultural implements are classified into three broad categories, the hand operated implements, animals operated implements, and tractors/power operated implements (Table 1.19).

TABLE 1.19
District Gurgaon
Density of Agricultural Implements and Machinery
(Per thousand hectares of net sown area)
1992

Implements	Gurgaon	Pataudi	Nuh	F.P. Jhirka	District
Hand Operated :					
Seed-cum-fertilizer drills	5.62	0.31	13.21	23.24	12.02
Seed drills	7.21	0.50	50.19	16.63	19.19
Thrashers	18.93	36.98	19.81	3.84	16.37
Wooden ploughs	40.84	21.11	39.60	140.20	67.80
Average density	18.15	14.73	30.70	45.98	28.85
Animal Operated :					
Harrows	1.07	12.06	10.09	1.4	4.24
Seed-cum-fertilizer drills	9.97	--	4.61	12.53	8.58
Seed drills	19.95	0.19	9.92	18.81	15.52
Average density	10.33	6.13	8.31	10.91	9.45
Tractor, Diesel and Power Oprated :					
Diesel pumpset	24.22	30.80	19.56	77.37	39.29
Electric pumpset	181.63	89.77	89.22	24.29	106.01
Tractors	32.31	12.74	35.17	33.91	31.65
Disc harrows	23.91	4.37	27.79	30.73	25.01
Seed-cum-fertilizer drills	25.94	1.25	26.32	22.34	22.72
Trailers	17.5	1.62	65.64	4.41	23.07
Harvestors	3.05	2.87	17.47	--	7.61
Other Implements	37.0	1.19	23.80	64.15	40.27
Average density	63.07	32.15	44.29	40.97	48.85

NOTE : Other Implements include chaff cutters, sugarcane crushers, power operated thrashers and repers.

Source : Agricultural Statistics Bulletin 1992-93, Department of Agriculture, District Gurgaon, Haryana

The hand operated implements include, seed-cum-fertilizer drills, seed drills, thrashers, and wooden ploughs. An average density of all these implements calculated for every thousand hectares of net sown area shows that as far as the use of these traditional agricultural implements is concerned, tehsil Ferozpur Jhirka ranks first. It is followed by the tehsil of Nuh, Gurgaon and Pataudi. Among others the first rank of Ferozpur Jhirka in hand operated implements is manily because of the highest density of wooden ploughs (140.20) and seed-cum-fertilizer drills (23.24). In case of seed drills the tehsil of Nuh is at the top (50.19). It is followed by Ferozpur Jhirka , Gurgaon and Pataudi tehsils. In case of thrashers Pataudi (36.98) is followed by Nuh, Gurgaon, and Ferozpur Jhirka.

The average density of animal operated implements shows that Ferozpur Jhirka tehsil is at the top (10.91), which is closely followed by Gurgaon (10.33), then by Nuh (8.21) and Pataudi (6.13). The tehsils of Ferozpur Jhirka and Gurgaon have much higher animal operated implements compared to the district average of 9.45.

The density of the agricultural implements and machinery which are operated by diesel, power, and tractors includes diesel pump sets, electric pump sets, tractors, disc harrows, seed-cum-fertilizer drills, trailers, tractor operated harvesters, and other implements like chaff cutters, sugarcane crushers, power operated thrashers, and repers. The distribution of the average density of these implements shows that the tehsil of Gurgaon is the only tehsil with a density of 63.07 as against the district average of 48.85. Gurgaon tehsil is followed by Nuh (44.29), Ferozpur Jhirka (40.97), and Pataudi (932.15). It will thus be seen that as far as the use of modern agricultural implements is concerned, tehsil Gurgaon is a leading tehsil while all other tehsils of the district are trailing behind.

CHAPTER - II

FACTORS AFFECTING THE LOCATION OF CROPS

Factors which generally do affect the location of crops are broadly classified into physical, economic, technological, fiscal, institutional and political factors on the basis of their inherent characteristics. A detailed account of these factors is discussed here which are relevant to agriculture in Indian setting.

PHYSICAL FACTORS

Among the general physical factors land, soil, and climate are important. These factors determine the nature and extent of land use patterns in agriculture, their conditions of production and set limits to the possibility of crop production in a particular area. These factors have significant effect on the incidence of cropping season, selection of crops, crop combinations, productivity of crops, cost of production and consequently on the dividends which are obtained from the agricultural produce. The net result is that instead of a particular crop being grown near the consuming centres under very diverse physical conditions, it is increasingly possible for it to be grown in those areas which physically are suited to the requirements of its production.

Land

The influence of land on the type of farming is exerted through its general smoothness and the degree of slope. The broken surface usually results in a high proportion of nontillable pasture land. Under such condition livestock play an important role in the farming system. Level land adds greatly to the facility with which labour and machinery may be used. Therefore, a crop which is most limited in climatic or other physical requirements of production, will, if the demand for it be sufficient, has the first choice of land.

Soil

Soil forms the basis of agriculture. The primary importance of the soil - the upper layers of arable land can never be overlooked. Soil directly influences the physical adaptability of crops. Certain crops are affected by the texture of the soil, others by chemical contents, and still others by the water holding capacity. Physical and chemical properties of the soils like depth, texture, stoniness, structure, drainage, consistency, organic matters, carbonates (more or less permanent factors), phosphates and potash contents (temporary factors); all have impressionable impact on the agricultural landscape of a region.

The physical soil factors are more important than chemical factors in assessing the potential value of land. Poor quality lands situated away from the village settlements are often reserved for grazing, while better quality lands situated near the village settlement are more suited to intensive cultivation.

Climate

Climate is the principal aspect of the physical environment affecting the type and intensity of cropping. Hence, the study of the distribution and intensity of precipitation, temperature and frost free period becomes indispensable. Every crop has upper and lower levels of temperature, rainfall, and humidity conditions beyond which it fails to survive.

Besides these general factors, there are some local factors which also determine the location of crops, such as soil exhaustion, soil erosion, drainage, natural irrigation, cloudiness etc. These factors also play their roles in the determination and selection of agricultural crops to be grown.

ECONOMIC FACTORS

The economic factors influence the nature and type of cropping through the prices of agricultural products received and prices of inputs incurred (Jr. Dunn,S.E. 1954). Some of the economic factors influencing the cropping pattern are discussed below.

Distance

Whenever distance affecting the cropping patterns is considered, it is related to the freight charges. This factor has its inherent influence which is exerted in all locational pattern of crop distribution. On micro-level to some extent, it dictates the type of a crop or crop combination to be grown on each plot of land while on macro-level the regional and global distribution of crop and farming systems are also modified under the impact of distance.

At the farm level i.e., on each plot of land, the effect of distance can be judged through the amount of inputs (labour, fertilizers etc.) applied to each plot. Generally, the cultivable plots located nearest the farmstead are applied with heavy doses of these inputs while the farthest plots receive the least. Thus, intensive farming is generally practiced near the settlements and less intensive farther away. The exceptions are of two types: the one when the yield is very large despite large inputs and small value like forestry, and the second, when average quantity of inputs yield a small bulk of valuable end-products like milk etc. The former may be situated near the market, the later at a considerable distance away. The factor of distance affecting the yield operates through the combined effects of transportation costs of the inputs and the time spent by the labour in travelling to and fro from his land holdings and farmstead every day.

Muller-Wille measured this distance in terms of time taken for travel. He found out that when more than one hour was required, the amount of manure used declines sharply. As far as the relation of production to distance is concerned, Wiiala (Chisholm, M. 1962) found out in a district of Finland that at an average distance of one kilometer, the gross return had fallen by 16 percent and the net return by 44 percent and, at two kilometers away the net return per hectare was very small. The reduced yields obtained on the more distance lands may be attributed to: firstly, at the margins of cultivation soils are inferior and, secondly, the size of the farm also increases. Hence the adjustment of distançe can be done in two ways - the same product may be enterprised less intensively, or there may be a substitution of products toward those which are less demanding of inputs. Hence, it is quite obvious that the intensity and the pattern of agricultural production is directly influenced by the increasing distance.

On a regional or global scale, the concern with the movement of goods is important than the movement of persons. It is known that access to a single transport artery is not always possible at all points like railways where access is only the stations which commonly have a settlement in its vicinity. The same is for canals, roads and rivers. The influence of these transport arteries on the cropping pattern is that the Thunonian production zones are no longer concentric in nature, and they are elongated in the form of bands almost parallel to these transport arteries having numerous agricultural settlements linearly arranged along them. This influence of distance which is stated above was quite strong before the development of efficient transportation technology. However, during the modern times the stereo-type relationship between the distance and the type of agricultural production has greatly diminished. It would not be out of place to state that those areas of the world where underground water is brackish, canal irrigation is absent and agriculture is mostly rain-fed, the above stated role of distance is still prominent.

There is another type of influence of the distance factor which is observed particularly after Green Revolution. It is distance, not from the settlement but from the source of irrigation like tube-well, canal, etc., which holds the key for a particular pattern of agricultural production since high yielding varieties of seeds and chemical fertilizers require much amount of water.

Market Price

Market price of a commodity is determined by the balance in forces of demand and supply. As the adjustment between demand and supply requires a considerable span of time, Marshall, A gives great importance to the time element in the determination of price level in a market.

Market price of the commodities influence the location of agricultural production and their zoning. Farmers are used to adjust a particular crop for cultivation in the scale of farm-gate price for each commodity, and thus, one would select that product or combination of products which would yield highest economic rent at a particular location and like-wise the most suitable methods of cultivation (Chisholm, M. 1962). Farmgate price of a commodity may be defined as the market price of the commodity minus its transportation cost as well as the handling costs and the dealers' profit margins if a commodity is brought into whole-sale business.

Every commodity has got a fixed market price which is beyond the local control, thus, for a farmer the only alternative left is to arrange the crops in such a fashion so as to yield the least transportation and production costs for that commodity which consequently will provide maximum return to the farmer (Smith, M.D., 1971).

Prices also influence the acreage under the various crops in two ways, First, the variations in the inter-crop price parities lead to shifts in acreage between the crops, second, the maintenance of a stable level of prices for a particular crop provides a better incentive to the producer to increase the output. In India, fixed procurement price of wheat and rice and other government controls have induced farmers to shift to cash crops like sugarcane and mustard.

Infrastructure

Infrastructure is of two types, the soft infrastructure and the hard infrastructure. The soft infrastructure includes rural services like banking, credit extension facilities, seed provision, local transport, communication and marketing of rural produce etc.(Wanmali,S. and Islam,Y.,1997). The hard infrasructure generally refers to road transportation. These transport services bring about significant change in the patterns of agricultural land use. The transportation rates on almost all commodities vary over distance and are much higher for short distances near the market than for longer hauls. Transportation cost of a commodity is a function of time and distance and the weight of the size of shipment, the physical landscape, the density and efficiency of a transport network and the nature of the goods to be transported. Von Thunen recognised that the introduction of an improved line of communication will lead to a reduction in the transportation cost along such an axis resulting in the extension of the production zones along that line, hence, distorting the very concentric nature of the production zones. Thunen's generalisation is that products with higher transportation cost related to their value will be produced closer to the market, and thus, ultimately along that transport artery.

Farm Size

A farm or an agricultural holding may be defined as a management unit, i.e., the area of land held for cultivation as a single unit by an individual, joint family, or more than one farmers on a joint basis. The term has also been used for the total area of land owned by an individual, joint family, or more than one farmer on a joint basis. The term has also been used for the total area of land owned by an individual or a joint family whether cultivated by the family or rented out.

In general farm size and fertility of the soil bear a type of relationship where the more fertile is the soil, the smaller is the farm size and vice-versa. Similarly, level of mechanisation and farm size are closely related in a positive bond where higher is the level of mechanisation, greater is the farm size.

Also, there is a close association between the farm-size and cropping pattern. The small farmers with small land holdings will be interested primarily in producing food grains for their own requirements. They would go in for cash crops only if they have met their requirements of food grains. Small land holders, therefore, devote a small acreage to cash crops than large land holders. However, recently a trend has been developed that almost all farmers, small and large try to grow some cash crops for example, the small farmers who have been increasing their sugarcane cultivation are more in numbers than larger farmers in India. It is mainly attributed towards a good diffusion of technical know-how, education and social interactions.

Another feature which is noticed is, that in small holdings intensive type of farming is practiced, while in large land holdings generally extensive type of farming is practiced.

Agricultural Labour Force

In economics 'agricultural labourer is defined as a person who works for wages in agriculture. Some economists use the term 'agricultural labourer' in the sense of total labour force in agriculture and which includes both self employed and hired workers.

Agricultural workers can be distinguished from industrial workers. First, unlike industrial workers, agricultural workers are highly unorganised. Second, agricultural workers belong mainly to one category - unskilled, in developing countries specially. Third, the employer - employee relationship is very different from that of industrial workers. Fourthly, agricultural workers possess migratory character. Finally, the annual earnings particularly of the casual agricultural workers are much smaller primarily due to low rates of wages and seasonal character of employment.

If an enterprise is labour intensive, or it needs skilled labour then labour will attract that enterprise to a particular location, like available cheap and abundant labour has encouraged the cultivation of paddy in countries of South-East Asia, parts of China and India. It is, therefore,implicit that the cost of labour also influences the location of an economic activity. It is not only a matter of hourly wages but also of hourly production. If rest of the things are same, the greater the savings of an area in labour cost (attributable to either low hourly wage rate or high productivity per hour, or both), the greater is the distance handicap, that could be managed in processing materials from far away sources for sale to far away markets (Alexander,W.J. 1963).

Demand

The demand of a commodity per unit of time is the function of the price of that commodity. According to A. Marshall, the greater is the amount of commodity to be sold, the smaller would be the price at which it is offered for it may find purchasers, or in other words, the amount demanded increases with a fall in the price and diminishes with the rise in price. Thus, there is an inverse relationship between demand and market price of a commodity.

The production of a commodity depends upon the demand of that commodity which is generated by the population size, and its distribution, and the occupation of population. Therefore, one of the most important elements of the total demand for agricultural products is the size of population itself. Any increase in population causes a proportionate increase in the demand for the various agricultural products and a proportionate increase in the central market price for each commodity if the supply is kept constant. Thus, the commodities intend to change their locations with respect to the intensity of demand.

TECHNOLOGICAL FACTORS

Technological change in agriculture consists of adoption of new farming techniques, research and development programmes aimed at bringing about diversification and increase in production and greater economic returns to the farmers. In fact an increase in the parameter of production is the result of the farm implementation of the new agricultural technology and its diffusion among the farmers. The use of fertilizers, high yielding varieties of seeds, pesticides and fungicides, improved irrigation facilities, new agricultural implements and contour bunding for the conservation of moisture and soil are some of the examples of such techniques. The following aspects are important.

Effecient and Cheaper Transportation

Changes in the transport technology also bring about far reaching modifications in the location of various crops. Earlier the transportation cost was proportional to distance but now a days there is a universal tendency for the rates per unit of distance to decline as the length of the haul increases.

The effect of technological change upon transport rate is two fold : a general decrease in the level of freight rates, and a tendency to decrease in normal tariff structure, i.e., the rates of long hauls in comparison to the short hauls. Both tend to encourage movement of materials and products over longer distances.

Transport cost becomes less in relation to the value of goods in three major ways. First, the substitution of the improved means of transport for more rudimentary methods like, the employment of faster horse instead of lumbering ox; and the replacement of faster horse by more efficient motor vehicles. Second, improvements within the individual transport medium, e.g., the provision of inflatable rubber tyres instead of the metal rims on wooden wheels common to many carts. Third, the greater degree of processing of by-products and changes in the type of products toward the more valuable ones, like production of butter and cheese from milk.

Improvements in the transport and related techniques have resulted in the enlargement of supply areas for the major urban concentrations of population. With improved means of communication, the importance of location with respect to the market diminishes and it causes a reduction in the relative importance of the rent (Chisholm, M. 1962). Due to this agricultural production has become profitable over more extended areas and the zones of production tend to move outward from the central market. The development of tractor from the bullock/horse drawn carriage has considerably widened the range of applications as a source of power for farming operations on sloping and rugged lands.

Industrial Development

Those industries which are directly related to agriculture as a raw material source, a change of technology in them do exert an influence upon the location of various crops. However, a direct influence is restricted only to those cases where weight loss or some such aspects of the conservation process gives a location dominance to the agricultural raw material, for example, sugar industry, textile industry and tomato canning industries. Thus, the technological improvements which increase the yield have a tendency to restrict the total production area and cause the production zones to move closer to the market, and also have a tendency in favour of all such products produced for the market.

Irrigation

The cropping pattern of a region is determined by the nature and availability of irrigation facilities. Wherever water is available, not only the different crops can be grown, but even a double and tripple cropping is possible with the provision of modern irrigation facilities.

In India it has been observed that the extent of the spatial variations in crop land use efficiency is directly related to the differences in the intensity of irrigation from place to place. The works of Blaikie, P.M. (1971), Shafi, M. (1977), Khan, M.F.K., and Fakhruddin (1981), Raina, J.L. (1989), and Rajkumar (1994), have the same findings.In the recent years improvements in the provision of irrigation facilities have greatly increased the acreage and cultivation of sugarcane, tobacco and other such crops.

In the areas of scanty rainfall, artificial watering of the crops becomes a dominant factor governing the location and production of crops. Vegetables which require large quantity of water cannot find a place in the areas of scanty rainfall unless they are treated with the required amount of water through artificial sources.

FISCAL FACTORS

The fiscal factors pertain to a treasury. The impact of agricultural taxation and capital input of a region has profound influence on the cropping pattern especially in Indian set-up.

Agricultural Taxation

Agricultural taxation assumes a special significance in the fiscal structure of an agrarian economy that launches big and bold development programmes and uses its fiscal tools for economic development. Broadly speaking, agricultural taxation includes taxes paid by the agriculturalists directly and also those borne by them indirectly. Direct taxes on agriculture consist mainly of land revenue, cesses and surcharges on land revenue, cesses on crops and agricultural income tax. Among the indirect ones are the sales tax, import duty, the motor vehicle tax and others which are paid by the consumers. Among these taxes, land revenue is the oldest of all taxes and most important tax on the agricultural land. Thus, in the countries where land taxation operates, location of agricultural products to some extent can be explained. Tax is levied on the assessed value of the net income derived from its operation (Chisholm, M. 1962). The crops on which more taxes are levied occupy selected locations since such crops can only be raised by those farmers who are economically in a sound position.

Capital

The availability of capital and monetary incentives at the village level are factors explaining localisation of crop land use types. It is established that for the operation of any enterprise in the first stage capital is needed. Considering a society where farmers are of varying economic status; rich farmers will be diverting their attention more toward the cultivation of cash crops and superior grains for handsome gains, while the poor farmers will divert their resources towards the cultivation of inferior grains in order to carry out their self-sustained way of life. But in a region where banks, cooperatives and private organisations are working to promote agriculture, they provide financial assistance to the farmers to purchase better seeds, fertilizers, agricultural machinery etc. Under such circumstances, the location pattern of various crops remains more or less uniform in a given region and every farmer tries to grow some cash crops and superior grains.

INSTITUTIONAL FACTORS

Under this category, the influence of religion, caste and customs/ traditions and education can be observed on the location of crops.

Religion

The influence of religion is significant on the locational pattern of agriculture. For examples, in Christian societies piggaries are encouraged, while in the Islamic societies piggaries are discouraged. Similarly, cow slaughter in a Hindu society is strictly prohibited.

Caste and Customs

Inspite of physical factors, market and transportation conditions, some commodities gain importance over the other in a particular region. It is the influence of customs and traditions, as well as, dietary habits prevailing in the region that sometimes become more important. In case of North Sudan, the importance of wheat is simply a matter of taste, the villagers of the north prefer wheat over dura. In the same context the case of Farrukhabad district of Uttar Pradesh a leading potato producer in the region can be cited. Here traditionally potatoes occupy more land than any other crop. While in the surrounding areas potato is not a dominant crop in spite of any difference in the climatic conditions and the nature of the soils. Thus, the customs determine both the form and the direction of economic activity in individual cases (Chisholm, M. 1962).

Literacy Levels

The customs and traditions and their influence in a particular region have a direct bearing on the society. Thus, the traditional crops loose their locations for new crops. In a community with low level of literacy, people are generally unfamiliar with new methods and techniques of agricultural operations. They enjoy a self-sustained economy and grow inferior grains with the use of primitive type of techniques. On the contrary, in a community with higher levels of literacy and technical know - how people are aware of the modern techniques of agricultural operations, they grow superior grains and prefer to grow cash crops.

POLITICAL FACTORS

The influence of government policies on the location of crops is well stabilized. In this regard the methods adopted by the government for the diffusion of agricultural technology and the agricultural planning are important.

In this respect main steps worked out by the government is the systematic formal/informal farm education. Agricultural universities and schools receive financial aids from the government. Many of these schools operate agricultural farms where the students are given an opportunity to become familiar with practices of agriculture. In universities and research institutions, the researches and trainings are conducted regarding the improvements in the techniques of agriculture, improved agricultural implements and high yielding varieties of seeds and so on.

Besides the teaching institutions, government has arranged for short term courses, lectures, demonstrations, exhibitions, bulletins, posters, films, regular radio broadcasts and television telecasts, clubs, societies and encouragements.

Sometimes government pay more attention towards the production of a particular crop. Thus, to achieve the goal, government provides all types of possible facilities like financial loans, subsidies, and advisory to the farmers, so that a particular crop is encouraged and occupy more new locations. A matching example in this respect which can be cited is that of Gambia (Barrett, H. and Browne, A., 1996), where until 1970 the vegetation production was highly limited to the dry season and was involving small scale production by individual women farmers for household use and petty trading. However, in 1970's vegetation production was revolutionised by The Collective Onion Growing Scheme introduced by the Ministry of Agriculture. This was an attempt to increase local production of onion in order to reduce large quantities being imported from Europe. This scheme was adopted with great enthusiasm by women farmers throughout the country,though,it was plagued with some of the problems at a later stage like inadequate marketing arrangements, selection of unsuitable variety of seeds, little quality control, poor storage devices,and uncompetitive pricing compared to importers. This produced disappointing results. The Collective Onion Growing Scheme, though, widely regarded as a failure did, however, familiarise farmers with collective methods of production and dry season agricultural techniques, enabling them to cultivate a range of other vegetables after the market for onions had collapsed.

It will thus be seen that a radical change in farming technology has occurred through the introduction of a new agricultural enterprise which is more profitable now than previously it was. However, transport facilities, improvements in refrigeration and agricultural mechanisation, improved agricultural institutions and legislation, and the positive role of agricultural societies necessitate the adoption of intensive farming system. The developments in irrigation technology, together with local conditions of the physical factors along with socio-economic and cultural factors have greatly changed the cropping patterns and locational aspects of cropping practices.

CHAPTER - III

THE CONCEPT OF RENT AND ECONOMIC RENT IN RELATION TO DISTANCE FROM THE MARKET

Rent/economic rent plays a significant role in determining the locational patterns of agricultural landuse in space. Transportation cost which influences the spatial pattern of landuse operates through the rent mechanism. The type of production which is capable of yielding the highest net return per unit of land on a particular parcel of land makes the highest bid for the use of that plot and vice versa.

RENT

Rent refers to 'contract rent', that is a periodic payment due from a tenant for the use of land, building or other property belonging to some one else in accordance with mutually agreed trust settled between them. It is usually payable in money, but is some times paid in kind. But, the 'rent' described by Ricardo and latter on by Von Thunen is in fact 'economic rent'.

ECONOMIC RENT

'Economic rent' is therefore, the return which may accrue to a farmer from a plot of land over and above that which can be realised from a plot of the same size at the margin of production. The land at the margin of production is one where cost and return just balance. Suppose the return from one hectare of such a land is x. By growing the same crope on a hectare of highly suitable land the return is x + a. Thus, 'a' becomes a measure of return per hectare over and above that which is possible from the land at the margin of production.. Therefore, 'a' is the economic rent.

ECONOMIC RENT AND THE DISTANCE FROM THE MARKET

Thunen supposes that the fertility of the Isolated State is of equal degree, and a farmer's profit per hectare will be equal to the amount received for that crop minus the cost of production per hectare and the cost of transporting the produce of one hectare to the market. If cost of production is assumed to be equal, the cost of transporting the produce to the market will determine his profit (rent). The farmer who has fields near the city will pay less transport expenses than one who is at some distance. The difference in the saving of transport cost per hectare will be the economic rent.

Economic rent decreases as the distance from the market increases. It is, thus, obvious that there may be several crops in competition for a piece of land, therefore, the land nearest to the market will be occupied by those crops which are more intensively cultivated and are capable of giving the highest return to the farmer. While the land which is far away from the market centre, owing to increase in transport cost will be less intensively cultivated and will yield less profit. This results in diversification of crops and leads to a zonation of production. Thunen's intensity theory and crop theory are inter related.

Dunn in 1954, presented a formula to calculate the economic rent as follows :

$R = Y\ (P-C) - YFD$

where:

R = Rent per unit of land (the dependent variable)

Y =Yield (in dollars) per unit of commodity

P =Market price per unit of the commodity

F =Transport rate per unit of distance per unit of commodity

C = Cost of production per unit of commodity

D =Distance from the market (the independent variable)

It is assumed that for a given time and place the values of 'Y', 'P', 'C' and 'F' are constant and, are therefore, parameters. 'D' than becomes independent variable which determines the value of 'R'.

In figure 3.1 marginal rent curve, through the bidding process, is shown for any given distance from the market. The cultivation of a crop 'A' will cease beyond a distance of 40 kilometres from the market, since production beyond this distance would result in a loss i.e., the negative return, as transfer cost exceeds the net return. Hence, the closer is the unit of land to the market, the more desirable it is. This will stimulate competition to control its use. In this way land will be allocated among farmers on the basis of competitive bidding between them. The location rent curve, therefore, can also be regarded as 'bid-rent curve', because, it gives an indication of how much the farmers would be prepared to pay for a unit of land at varying distances from the market (Lloyd,P.E. and Dicken,P. 1972).

After discussing the profitability of farming a single crop, it can be examined how the production of different crops will be related to distance from the market. For each agricultural product there will be:

i. A specific market price depending upon the supply-demand relationship of the crops.

ii. A specific transportation cost which will vary in accordance with the nature of the product-its bulkiness, perishability and, general transportability .

iii. A basic cost of production, which is assumed to be constant in space for any one crop.

iv. A specific yield per unit of land.

Thus, each product will have a different bid-rent curve. The height of the 'Y-axis' intercept will depend on the market price for the product and the slope will vary according to the transportation characteristics of that product.

Figure 3.2 shows how the level of location rent or economic rent determines which crop will be produced on a given unit of land. From this three dimensional diagram, one can read that the slope of the rent line is affected by the cost of transportation which is determined by its relative bulk and weight and other consideration like perishability. Product 'B' can be produced outward to a distance of 80 kilometres from the market. Between the market and 26 kilometres distance, the location rent curve for 'B' is however, consistently below that of 'A'. Hence, the producers of crop 'A' can bid higher rents than producers of crop 'B'. Crop 'A' will, as a result occupy land within the radius of 26 kilometres from the market. Crop 'B' and 'C' with lower bid-rent curves in this area, will be excluded. Beyond 26 kilometres, however, product 'B' can outbid both 'A' and 'C' until a point of 48 kilometres from the market is reached. Beyond which, till the margin of cultivation, only product 'C' will be produced.

If it is envisaged that land use zones on the horizontal axis (Fig. 3.2) being rotated around the market, the result would be an agricultural landuse pattern of concentric rings or zones. Each zone accommodates the type of landuse that yields the highest location rent. The rent curves, therefore, would be more properly depicted as rent surfaces. The spatial organization of production will depend on their respective rent curves.

After considering the ways in which competition between single product promotes a concentric zonal land use monoculture, which may be an exception rather than the rule, it is, therefore, more realistic to think in terms of product combinations. Although, the same basic principles operate as in the single product case, the location rent or bid-rent curves apply this time to the combinations of products in totality . In Figure 3.3 the combination of products ABC yield one rent curve and, the combination of ABD another. 'A' and 'B' will be produced over the entire area, but, between the market and point 'X' in combination with 'C' and beyond 'X' in conjunction with 'D'. Thus, the same crop may appear in several rings, also the number of possible rings is increased to the number of possible combinations of products demanded by consumers.

RENT CURVE FOR A SINGLE AGRICULTURAL PRODUCT

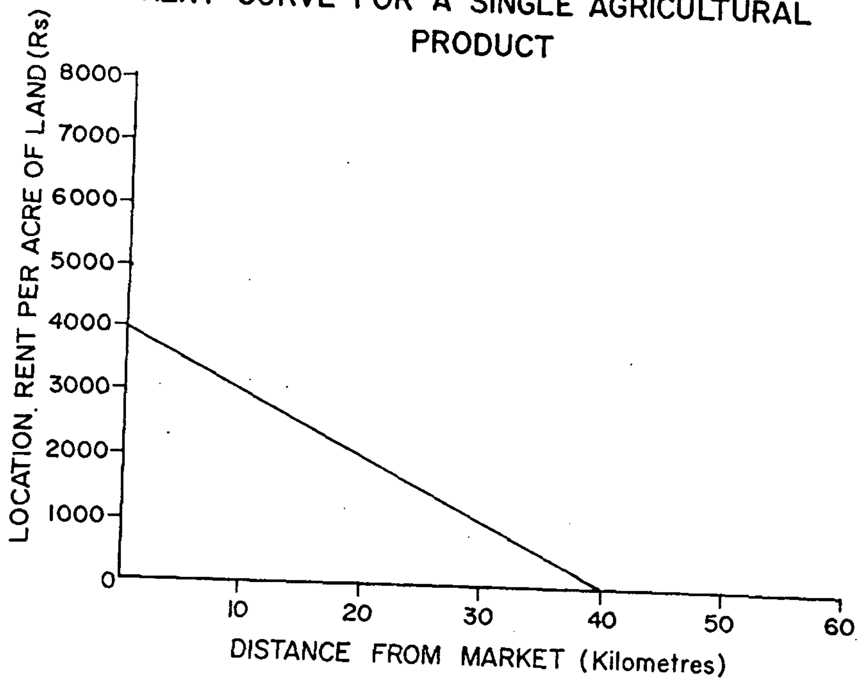


Fig. 3.1

PATTERN OF AGRICULTURAL LAND USE IN RELATION TO CENTRAL MARKET

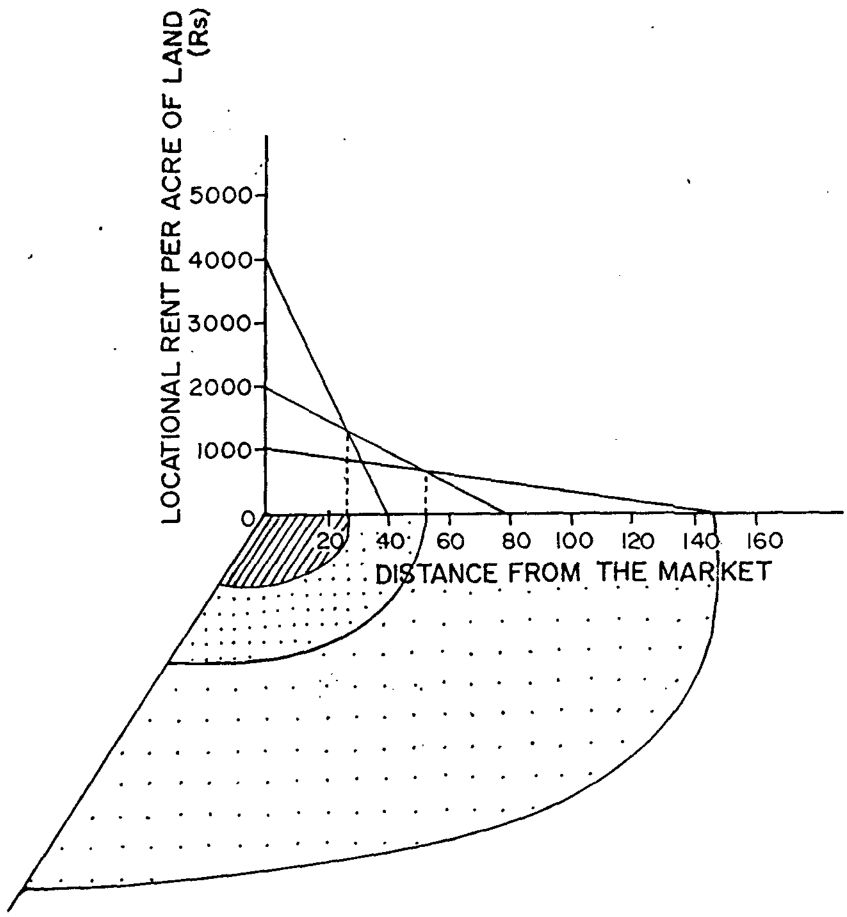


Fig. 3.2

The concentric zonation of the crops (individual or combinations) stated so far, was based upon the influence exerted by transport costs on the economic rent yielded by units of land at increasing distance from the market together with the sensitivity of different products to the cost of transportation.

A rather different view is taken by Sinclair (1967) who suggests that in developed economies although the basic allocating force governing land use is economic rent yet the major force influencing spatial variation in economic rent is no longer simply a transport cost to the market. Sinclair argues that the most potent force is massive urban expansion hardly envisaged in Von Thunen's time. Urban land invariably commands a higher value than rural land and, where the two types of uses are in direct competition, urban land uses invariably win, moreover, the land that is expected to become urbanised also enjoys a higher value-an "anticipated" value and, this has a considerable effect on the type of land use. In Von Thunen's model, as well, land adjacent to the urban market was farmed at the highest intensity. However, such land is most likely to become urbanised and is flavoured by the highest anticipated value. Under these circumstances a land owner or a farmer is not likely to invest large amounts of capital and labour in agricultural production.

The value of land for agricultural purposes, therefore, according to Sinclair is lower, close to an expanding urban centre and increases with distance as the likelihood of urban encroachment declines.

LENGTH OF HAUL AND LOCATION

The tendency of transportation cost to drop with the increasing length of haul is directly related to the problems of location. This characteristic of long haul economies in particular, tend to encourage greater volume of long distance movement and emphasise less on short distance movement. This effect results from the interrelationship between two types of cost. First is the fixed terminal cost payable for loading and unloading, weighing, clerical work, switching and car detention at each point of its journey. Second, is the line-haul costs which include outlays for fuel, equipment wear and maintenance, as well as crew cost; it tends to increase with distance.

Each type of transport mode tends to have its own cost structure like terminal and fixed cost are typically highest for water movements as a result of expensive port facilities and equipment required, but the variable and line-haul costs are usually lower than those of other forms of transport. By contrast terminal and fixed cost are least for motor trucks, but their line-haul cost are highest.

Except the most primitive means of transport, the line-haul cost rise at a constant rate from the origin. Ordinarily, the cost per mile is highest during the first few miles of journey, after which unit-distance cost gradually eases out.

This long-haul advantage favours production at terminal points. The minimum transport cost sites are at either ends of the journey which makes sales and purchases possible at greater distances and therefore, extend market and supply areas of all type of production. In case of agricultural production, the existence of tapering freight rates transform the rent lines from a linear to curvilinear shapes (Fig 3.4). In effect this

RENT CURVES FOR COMBINATION OF AGRICULTURAL PRODUCTS

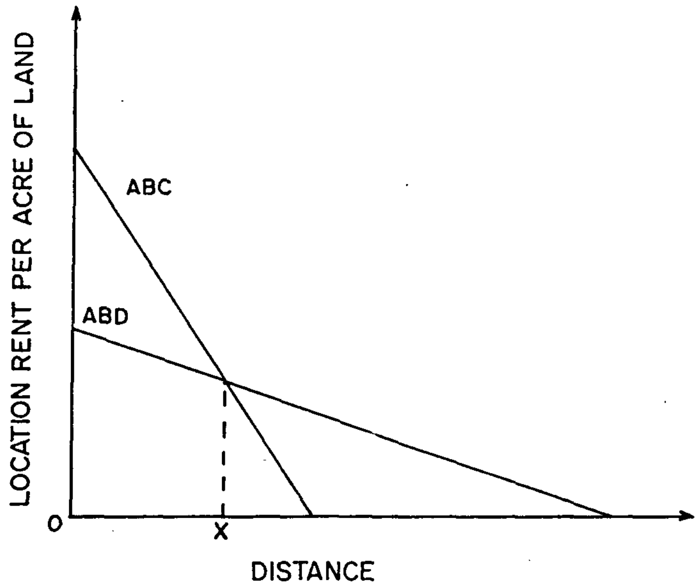


Fig.3.3

AGRICULTURAL RENT CURVES
The Effect of Tapering Freight Rates

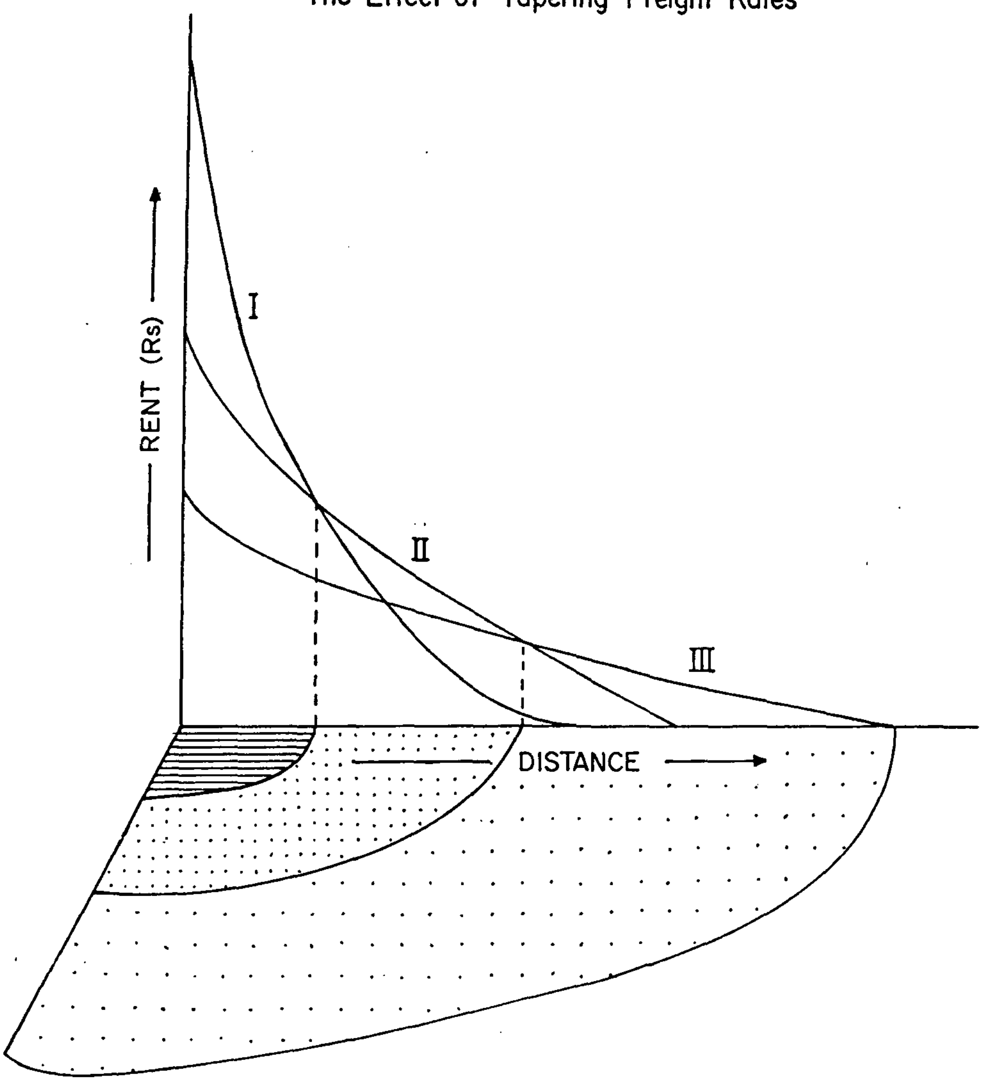


Fig.3.4

price for the farmer declines more rapidly at a distance near the market than at equal distances further away.

The long-haul advantage not only increases the spatial limits of the market areas, but also permits to invade the market areas of a competitor. As a consequence, there are not only large market and supply areas, but also the boundaries to such areas which become highly irregular. In addition, the grouping of freight rates into distance zones leads to the overlap of market and, supply area boundaries.

Declining relative importance of transport cost means, that other factors gain significance, like the change, and expansion that has taken place in the location of intensively cultivated horticulture crops. These crops were formerly grown in immediate vicinity of the market, today, they tend to be concentrated in areas offering the greatest natural advantages with only small pockets remaining at the urban periphery.

CHAPTER - IV

A THEORY OF AGRICULTURAL LOCATION

A normative economic model of agricultural location was first presented in 1826 in "Der Isolierate stat". This book was written by John Heinrich Von Thunen who was a German economist and was a follower of Adam Smith, the renowned economist. The model presented by Von Thunen is based on an econometric analysis of the states in Mecklenburg near the city of Rostock, Germany, with their sod-podzolic soils of low fertility, where he farmed for forty years from 1810 until his death in 1850.

The core of Thunen's mini-max model lies in the concept of economic rent which is inherent in farm-market distance relationship. The basic idea is that the form of agricultural landuse which produces the greatest rent will make the highest bid for the land, and thus, displaces all other uses of the land. The model is predominantly concerned with the agriculture, its types, and prosperity about an urban market. In order to design his theory of agricultural location, Thunen collected relevant data over a period of five years from his own state of Mecklenburg and analysed them. The data were pertaining to the cost of production of various agricultural produce, their yields, cost of transportation of the agricultural produce to the market, as well as, their market prices. On these bases he drew six concentric zones with different agricultural production. These zones were mainly determined by the transportation cost. For the purpose of model building Thunen postulates:

1. There was an isolated area/Isolated State, having least economic relations with the world outside. The Isolated State was having a city in its core, and agricultural hinterland around the city.

2. The city was the only market for the surplus agricultural produce.

3. The agricultural hinterland was homogeneous in physical conditions of climate, and physiography.

4. The hinterland was traversed by only one mode of land transportation-the horse and cart, with no navigable river.

5. The transportation cost identically was directly proportional to the distance covered.

6. The farmers of the agricultural hinterland were desirous of maximizing their profits and were capable of adjusting their types of farming to the market demand.

7. There was a state .of free competition among the users of the land. On these assumptions Thunen postulated that, given this controlled laboratory system, the different types of agricultural land uses would develop around the city in six discrete concentric zonal rings of agricultural production.

8. Thunen assumed that each individual farmer has complete information and makes rational decision to maximise his profit in the light of his complete knowldege.

In fact Von Thunen was mainly concerned with the monetary return over and above monetary expenses incurred by different types of agriculture i.e., "The Economic Rent", which decreases with the increasing distance and with the decreasing intensity of cultivation of a particular crop from the city market.

Von Thunen recognised following six concentric zonal rings of agricultural production (Fig. 4.1).

ZONE 1 : The land adjacent to the market would be used for free cash cropping i.e., market gardening and milk production, because of their high perishable nature, primitive type of time consuming transportation system and the absence of adequate techniques of food preservation like refrigeration and canning etc. The radius of this zone is directly proportional to the demand of these products in the city. Since a particular size of city population would require a certain volume of milk and vegetables, these urban consumers would be ready to pay higher prices for milk and vegetables. This would ultimately make it a more profitable venture for farmers in Zone-1 as compared to any other type of agricultural production. This type of agriculture yields a higher return but incurs heavy transportation costs; consequently its rent curve drops very steeply away from the urban centre.

ZONE 2 : In this zone the inhabitants specialise in producing wood, with fire-wood in much greater demand than lumber. From the modern view point this would appear a peculiar use for such an expensive land with second nearest location from the city. However,in Thunen's time this was quite logical. Being a principal fuel and exceedingly bulky, wood was costly to be shipped by the primitive transportation medium. The rent curve for this type of landuse dropped quickly away from the centre. Low production cost added further to the feasibility of free cash farming in this ring. That way, Von Thunen demonstrated that forestry yields greater returns to the farmer near the city than any other type of production except that of fluid milk and market gardening products. The outer limit of this zone was determined by the amount of wood demanded by the market.

ZONE 3, 4 AND 5 : These zones surround the woodland and are devoted mainly to the grain crops. The intensity of cultivation in these zones diminishes outwardly from the centre as indicated by :

i. The proportion of fallow land, which is zero in zone 3, fourteen percent in zone 4, and thirty three percent in zone 5.

ii. The corresponding drop in production cost per acre, especially in labour requirements, is thereby compensating for the additional burden of transport cost of these outlying areas. Hence, in Thunen's model, there is a cost substitution with transport costs replacing production costs.

ZONE 6 : This would be a region of live stock ranching. Marketed products would be of two types : live stock which could be driven to market, hence the transportation cost almost become zero; and by-products of milk like cheese, butter etc., which are not highly perishable and have a remarkable reduction in the volume resulting in lessening of the transportation cost.

On its outer extremity, this sixth zone was bounded by wilderness, a resource that could be exploited at some future time when the demand for agricultural commodities in the city would require an outward expansion of the productive area.

MODIFICATIONS TO THE CLASSICAL MODEL

Thunen himself considered the potentially distorting effect of improved transportation routes as navigable waterways, roads and railways on which transportation was speedier and costs only about one tenth (along waterway) that of land transportation. As important cities generally have access to a navigable waterway, Thunen introduced a stream into his "Isolated State" resulting in the elongation of production zone roughly along the stream. Zone-1 was least changed in shape; zone -2 extended in a narrow band for some distance in each direction from the city, but it was no longer an enclosed zone and instead of approaching close to the town it seems more likely that wood lands would have been situated at some distance up and down the stream. Since, the transportation cost of wood was very high vis a vis its value, the river-side location was a most favoured location for this form of production (Fig. 4.2).

The provision of only "one market" was also subsequently removed by Von Thunen. The consideration of a minor market centre with its own small tributary area apparently with the production of Zone-1 type, opens up the possibility of numerous towns of roughly equal importance with intermingled production zones which modify each other. This leads towards the extreme complexity in the real world where the zonation around the individual cities is rudimentary or indistinguishable

VON THUNEN'S SYSTEM OF AGRICULTURAL LANDUSE

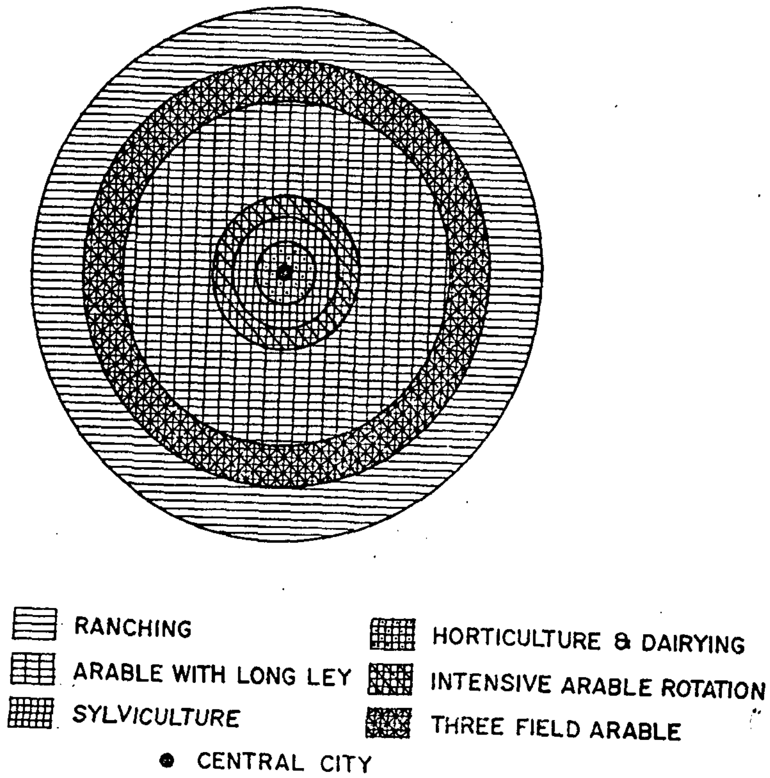


Fig.4.1

THUNEN'S ISOLATED STATE

EFFECTS OF NAVIGABLE WATERWAY AND A SECONDARY CITY

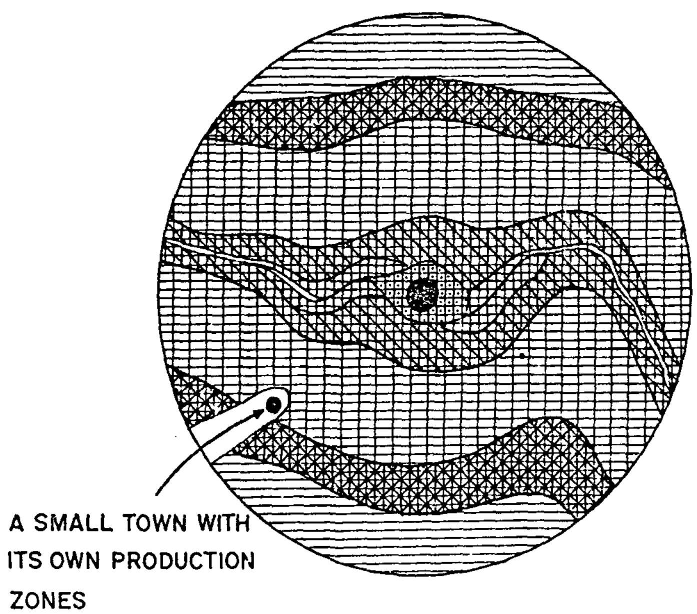


Fig.4.2

(Rakitnikov, A.N., 1978). Figure 4.3 shows a situation for a simple two market case. Both centres have the inner landuse zones organised in a concentric manner around them similar to that of a single market. However, the outer zones are displaced and take on an elliptical shape because of their orientation towards two markets rather than one. The line between them marks the boundary between the two competing supply areas. The existence of more than two markets (Fig. 4.4) produces a more complex picture. The products of the inner rings are oriented towards the individual towns, but those of the outer rings are oriented towards the entire cluster of centres. This complex graphical problem does not alter the conceptual framework of the analysis. The fundamental allocating mechanism of the bid-rent curve, based on location, remains the same.

VON THUNEN'S MODEL - AN ASSESSMENT OF ITS VALIDITY

The model presented by Von Thunen has evoked many discussions among the economists and social scientists. He developed two themes in his model of agricultural production : one, the theme of cropping intensity and the other that of crop landuse. However, the latter reflects upon the intensity of cultivation itself. The input cost increases and economic rent decreases with increasing distance from the market. The landuse or crop theory to correspond with spatial organisation of crop landuse around the market place is governed by the rationale of profit maximisation. Hence, it depends upon the yield of crops, money value of per unit of crops and the accrued transportation cost per unit of crop produced. The intensity theory states that cropping intensity decreases with increasing distance from the market place. It corresponds to the decreasing area of double cropping away from the market centre. Hence, intensity theory explains that intensity of agriculture depends on the farmgate price a farmer

EFFECTS OF TWO MARKET CENTRES ON AGRICULTURAL LANDUSE ZONES

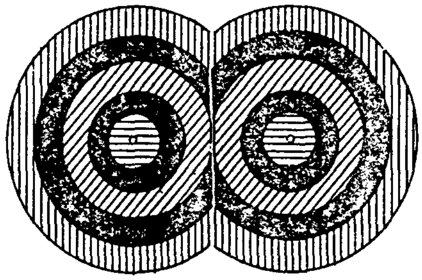


Fig. 4.3

EFFECTS OF MULTIPLE MARKET CENTRES AGRICULTURAL LANDUSE ZONES

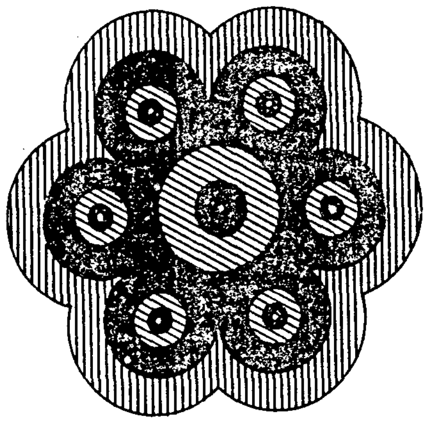


Fig.4.4

SOURCE : Lloyd, P.E. & Dicken, P. (1972). Location in space. A Theoritical Approach to Economic Geography. LONDON. P. 21 & 20.

receives for his agricultural produce minus the transportation cost, and the distance from the market. To compare the model of agricultural location put forward by Von Thunen with the present day agricultural systems of the world, it would not be out of place to mention those points which are the valid reasons for suggesting drastic changes in the whole body of the model, though, the efforts are not to reject the model altogether. The need of the reassessment of the validity of the thunen's model arises out of the modern scientific, technological and social changes which are taking place gradually ever since Thunen put forward his hypothesis. These changes are dynamic and are actively engaged in redefining and reshaping the Thunen's model of agricultural location. Thunonian concentric zonal agricultural pattern is something rare in the context of the present day world. Such pattern was a dominant characteristic of agricultural production in the past, as in 1811 around London, despite the wide variety of soil types, agriculture was arranged in a series of concentric zones. This type of circular zonal agricultural pattern has been modified by the numerous complexities in the modern times, therefore, an assessment of both, the validity of the Thunen's model and the doubts about it, is essential. It is suggested that remains of pre-existing zonal pattern of agriculture can still be cited in the form of the inner most zone of agricultural production with intensive market gardening and liquid milk production around urban centres. Gottmann, found out that agriculture in megalopolis is highly specialized, with emphasis on market gardening, dairying, poultry and animal husbandry.

About the Thunonian zonal rings of agricultural production, Losch (1954) pointed out that in the two-product case, rings would occur in only ten out of twenty seven possible cases. Certainly a number of conditions must be fulfilled for concentric land use rings to be evolved. Dunn (1954) further suggests that although the ring formation is clearly not visible in the two-product case, it almost certainly appears where multiple products are involved.

Some theoreticians feel that Thunonian approach regarding the distance to the market, as a basic factor in the analysis of spatial differentiations of the farm production systems is not altogether correct; because the locational patterns of the markets themselves need analysis. Distance may not be, therefore, fully responsible for the cropping systems and their patterns.

As far as the cost of transportation is concerned, Von Thunen does not limit himself to differences in transportability as well as to the effects of the length of haul on the transport rates in determining the location of farm production. The existence of long-haul economies in particular tends to encourage a greater volume of long distance movement with less emphasis upon short-distance movement. It makes sales and purchases possible at a greater distance and, therefore, extend market and supply areas of all types of products. In effect the price to the farmer declines more rapidly at distances near the market than at equal distances farther away.

These tapering freight charges transform the rent lines from a linear to a curvilinear shape, with the result of increasing spatial extent of market areas, also permitting to invade the market area of a competitor resulting in the larger market and supply areas with highly irregular boundaries which often overlap each other. However, this does not necessarily destroy the zonal pattern of production. No doubt, the differential land rent, spatial differences in wage levels, and the prices of the means of production determine the locational patterns of the agricultural crops. But Von Thunen is quite logical to conclude the uniform real wages throughout the state and varying prices of the consumer goods in order to build up an ideal operation of the "law of value". Considering the "law of diminishing productivity of incremental outlays", the relationship between the levels of farming intensity and physio-economic factors set up by Von Thunen needs a reassessment, because he shows by his calculations that a relatively market oriented worse location is better for more extensive landuse, in which, soil nutrients are restored by natural processes, while a better transport-geographic situation is a justification for more intensive production systems. In this case, it is not the higher price received for grains but the prospect of driving higher yields from better soils that makes it economical to invest more inputs per unit area. Any decision to intensity the type of agricultural must be based upon the prospect of increasing yields as well as profitable operation in terms of costs and income. Preferable should be the one that would yield the maximum surplus value per unit of incremental outlays (Rakitnikov, A.N., 1978). Moreover the farming intensity is sometimes affected by religious taboos, distinction between rural-urban tastes, dietary habits, differences in income and level of development, enterprenurial skill their motivations and the extent of knowledge as well as governmental interference.

The optimal production system varies from place to place, and on the same place from time to time due to the fluctuations of demand and other factors. Thus, the false law of "diminishing productivity of incremental out lays" is insufficient to justify the differences in agricultural intensity levels for different conditions of location and land quality. At the same time Thunen's assumption that all the farmers in the 'Isolated State' were bent upon maximizing their income virtually does not hold good, because only the better trained, more highly motivated farm operators have such goals, many of the rest desire only to continue in their inherited way of life, satisfied with less than their full capabilities, and placing more importance to leisure.

Such farmers bank their decisions pertaining to the selection and location of crops upon the ever fluctuating prices, and costs in order to book maximum profits to the best of their guesswork. Hence, their decisions are based upon maximum likelihood rather than deterministic approach. It is therefore, imperative that farmer's behaviour should also be examined related to normative economic model formulations.

As far as the relationship between the type of farming and technology of production is concerned, Von Thunen was able to highlight the differences in the technology of cropping and livestock management to objective economic conditions. Lastly, it can be argued that the patterns seen by Von Thunen about 170 years ago have been profoundly modified by the continuous improvements in technology, the transport technology in particular, such as refrigerated ships, trucks, railways, cars, etc., resulting in :

1. A long term persistent downward trend in transportation charges, reduced transit time, and more efficient handling methods. This

was aimed to level out regional differences, especially in the farmgate prices, received by the farmers. This proportionately reduced the force of the market attraction, and the role of distance friction for agricultural production, and brought about a corresponding drop in the slopes of rent-curves.

2. Easy and safe movement of perishables, like large scale export of butter, cheese, and chilled meat from New Zealand to the United Kingdom; similarly the increased speed and cargo carrying capacity of modern aircrafts have increased dramatically the transportation of range of flowers and small fruits safely to long distances, like the air lifting of California strawberries to New York, London, and Paris, as well as, transportation of rose buds and mangoes from India to several destinations in Europe.

In spite of all these modifications, concentric zonation of agricultural crops may still be recognized on a continental basis (Chisholm, M. 1962). However, no principle to determine the line of demarcation between the two forms of land uses has been elaborated by Thunen and his generalisations about the crop transition are inadequate. These inadequacies in his analysis can be attributed to his preoccupation with the empirical data gathered from his private estate.

Hence,in modern times the relevance of Von Thunen's hypothesis can be assessed only in the presence of laboratory conditions to be evolved in accordance with the existing socio-economic and technological conditions of his time.

CHAPTER - V

TESTING OF VON THUNEN IN OTHER PARTS OF INDIA

In response to urbanisation and rapid technological changes in agricultural practices all over the world, there is a growing awareness amongst agricultural scientists to test the problem of land values and farming intensity in relation to varying distances from the settlement. From the late 1960's the thrust is upon to get maximum output from the minimum input of resources through optimisation process. Von Thunen's work was aimed examined towards the study of existing agricultural practices in northern Germany of the early nineteenth century.

His suggested spatial organisation of the agricultural production had a strong empirical ground of concentric landuse rings around an urban market. The zonation was the result of the degree of impact of transportation cost on the location rent yielded by the unit of land at increasing distance from the market along with the degree of sensitivity of different products to the transport cost.

The normative concept of location of crops and cropping intensity in relation to varying distances from the urban centre has proved a widely tested and approved deductive model in the developed economies. However, Von Thunen's location theory was evolved in the context of a market economy prevalent in Western. Europe in early nineteenth century. The nature of economic development in face of mounting pressure of population in a country like India in twentieth century has produced an agricultural market system of its own. The decisive role of distance as obsèrved by Von Thunen in location of crops and cropping intensity has not been found so true.

In this regard the contributions of Blaikie,P.M., Shafi,M., Fakhruddin and Khan,M.F., and Raina,J.L. are of much significance.

Blaikie (1971) has investigated the internal layout and its effect on spatial organisation of cropping patterns of four villages selected from north India, out of which two villages namely Daiikera and Keru are situated in the western part of Rajasthan state. The remaining two villages Diighal and Berwala are located in The Punjab Region within 80 kilometers of national capital of Delhi. The village Berwala is located in the state of Delhi itself, while the other village Diighal is near by the city of Rohtak in Haryana State.

Rajasthani villages with unreliable rainfall practice extensive agriculture, one crop a year,with a small area of land irrigated by wells which are of great economic importance to the village. A traditional system of transportation consisting of rough dirt-tracts is used by traditional bullock carts. The extensive unirrigated and only rainfed agriculture involves large distances between the farmer and his farther land holdings, which is some times up to a distance of ten kilometers. Within irrigated lands maximum distance between village settlements and farmlands is under one kilometer.

The Punjabi villages have a more reliable rainfall and can grow an unirrigated crop during the winters in good monsoon years. Also the canal and well irrigation serve a high proportion of village lands. The quality of irrigation service is affected with the distance from the inlet of a major channel into the village lands and with the order of the channel. Access to the fields along the tracks is a particular problem for, carts can not be taken across intervening fields, when there are crops planted in them.Trans-shipment and porterage of bulk to and from the track is,therefore, often necessary.

On these conditions a modified version of Thunen's model was applied by Blaikie, in which:

i. The distance was measured in hunderds of meters rather than hundreds of kilometers. In this respect three observations were made in order to show that distances involved in different operations during the cultivation of crops do add significantly to the total production cost. Firstly, the transport (camel/bullock cart and porter in the order of cost per kilometer) is expensive. Secondly, the transport routes are muddy and circuitous, and bulk movement often requires costly trans-shipment. Thirdly, transport of bulk (mainly the application of farmyard manure before ploughing and the cartage of the harvest back to the village core) has to be considered when other demands on labour are high.

ii. Total transport outlays were taken into account instead of the transport outlays involved in taking the product to the market.

iii. The effectiveness of the price mechanism in controlling farm management decision was not necessarily the controlling factor in cropping decisions. In other words it can be said that market price was not considered as the controlling factor in cropping decisions. Moreover, the extent to which cultivators grow specifically for the market is governed by a host of other complex factors. Thus, economic rent alone is not a criterian for cropping on individual holding. So there exists a problem of non-optimum decision making in all normative models of peasant societies.

Unlike Thunen's model where the production unit was considered to be at one location, the situation in village India,when Blaikie conducted this study was, that most of the cultivators had several fields at various locations and distances from the village core i.e., the consolidation of land holdings was not undertaken at that time. So, it was not the question of producing one product or product mix which would yield maximum economic rent at one location but it was a matter of allocating crops to a certain number of locations/fields at varying distances from other factors of production,like irrigation facilities,farmyard manure etc. Moreover, since it was only one production unit existing as a scattered number of different plots, some sort of rotation of crops had to be practiced which prevented stable concentric patterns of crops existing from year to year.

Blaikie has used a more generalised model as compared to that of Von Thunen in which he has used the concept of minimisation of movement rather than the normative concept of rent maximisation. The hypothesis has two parts. First part states that each cultivator according to his survival algorithm decides area allocations for various crops. He grows those crops for which total transportation outlays involved in cultivation increase most rapidly with increasing distance i.e., closest to the source of inputs rather than settlement. This can be recognised as the modified version of Thunen's theory of crop growing. The second part states that, the intensity of production of any one crop would decrease with increasing distance within any one farm, although not necessarily between farms bacause of variations in the farm resources. This part of the hypothesis is a modified version of the theory of intensity of Von Thunen, which states that with increasing distance between market and producer, two sets of substitutions take place. Firstly, a substitution of rent for transportation outlays, and secondly, other outlays of capital and labour for land.

Using a variety of mutivariate statistics comprising of 100 percent areal coverage, Blaikie carried out simple regression and principal component analysis. Component scores were generated for isopleth mapping of component scores. Kolmogrov-Smirnov test was applied to test the influence of transportation requirements on the zonation of certain crops with varying distances around the village core and, in a significantly different distribution from one that would be expected if the crop was grown equally in all zones. A second block of data of the villages under study pertaining to sample fields from the sample farms, was given a soft treatment of simple regression analysis. The final experiment was attempted to bring together farm structure variables and field variables in a series of multiple regressions. Sequential multiple regression and best fit analyses were the two chief types of experiments which were carried out. Various other simple regressions were calculated to follow up side issues in order to illuminate the main avenues of research. Applying this methodology Blaikie obtained the following results.

The crop zoning in Rajasthani villages Daiikera and Keru was having the following concentric zones from the village core.

Zone No.	Zone width from the village core in kilometers	
	Daiikera	Keru
I	0.0 - 0.8	0.0 - 1.6
II	0.8 - 1.6	1.6 - 2.4
III	1.6 - 3.2	2.4 - 3.2
IV	3.2 - 4.8	3.2 - 4.8
V	4.8 - 6.4	4.8 - 6.4
VI	6.4 - 8.0	--
VII	> 8.0	--

In Daiikera in Zone-I, those fields were also included which were belonging to the cultivators in permanent satellite villages within the village lands of Daiikera. Similarly in Keru's case, many satellite villages and their lands were included in Zone-I, although they were more than 1.6 kilometers away from the major village core.

The crops wheat, Jowar, Bajra, and chifter were chosen for Daiikera village; and Bajra, Jowar, and Moth for Keru. The results obtained were:

DAIIKERA

i. Wheat, chifter and Bajra were grown in distributions significantly different from those of the other three crops under study.

ii Jowar was grown in a distribution significantly different from that of the other three crops under analysis.

iii. Preferred planting distances obtained were:

Wheat < Jowar; Wheat < Bajra; Wheat < Chifter;

Chifter < Bajra.

iv. The association of crops with zones was found to be :

Zone-I Wheat (very strong), Bajra (moderate)

Zone-II Wheat (strong), Chifter (strong)

Zone-III Chifter (strong), Jowar (weak)

Zone-IV Jowar (weak)

Zone-V No outstanding crop

Zone-VI Bajra (moderate)

Zone-VII Bajra (weak)

v. Thus, the order of crops with increasing distance was wheat,chifter, Jowar, and Bajra with a qualifying statement that Jowar and Bajra are not preferentially grown in distribution different from that of other crops, when all zones are considered together and at the same time they are not clearly differentiated from each other.

KERU

On the same lines the allocation of crops to the zones in Keru were as follows.

Zone-I Bajra (strong), Jowar (weak)

Zone-II	Bajra (moderate), Moth (moderate)
Zone-III	Bajra (moderate)
Zone-IV	Moth (moderate)
Zone-V	Gowar (weak)

Thus, the order of crops with increasing distance found to be was, Jowar and Bajra together,and then, Moth and Gowar together, with no defenite differentiation within the two pairs.

The transport outlays involved per man/day for each crop were calculated, and were placed in an order so that the first crop would be that one, the total transportation outlays involved in cultivation for which increase most rapidly with the increasing distance. The results showed that the crops with respect to the order of increase of total transport outlays with increasing distance were wheat,chifter,Jowar, and Bajra which exactly matched with the previous results. It is worth noting here that, unlike the order of intensity of crops, this order of crops accords well with the Thunen's model,where forest products constitute one of the inner zones. Chifter is a transport intensive crop used as fodder. The analogy between forest zone and chifter zone is obvious,and show that crop rings are not necessarily characterised by increasing intensity with decreasing distance from the centre.

In Keru the crop zoning is less clear. Jowar is very evenly grown through out the village and Bajra less so. The order of crops with increasing distance is Jowar/Bajra,Moth and Gowar. It is due to Keru's more dispersed settlement pattern, which enables transport outlays to be cut, thus, allowing factors other than transport outlays to control cropping patterns.

For both Punjabi villages (Diighal and Berwala), a grid of 25 acre squares was laid over the village lands and the same procedure was followed as that of Rajasthani villages. Distance from the village core was measured as a straight line distance. Mean daily wage equivalents were left unadjusted for, the correlation co-efficient between inputs and distance was very low and did not warrant any adjustment. Mean planting frequencies per agricultural season per 25 acres for all crops in both villages were calculated by summing the total fractions of each field planted with each crop included in the square, and then, dividing the total by (6 x 25) .In the case of Berwala, irrigation data were also available and were included in the experiments, the total being calculated in exactly the same way as for crop frequencies.

DIIGHAL

The simple correlation matrix for the village Diighal is characterised by low value co-efficients, except +0.5 which is between sugarcane and inputs. The sugarcane crop commands intensive application of labour, farmyard manures and irrigation. Wheat has a moderate correlation with distance which means that wheat is prefrentially grown away from the 'abadi' (habitat). The low correlation between the different crops show their relative mixing with 25 acre grid cell. The impressions of main crop standing over large number of fields are altogether absent.

The principal component analysis for Diighal reveal that the Component I (Irrigation-Sugarcane-high input component) explains 34% of the total variance, and is co-dominant with Component II.

It has high loadings on wage equivalents and sugarcane in exactly the same way as for Berwala. The areas of highest input always occupy village peripheral position where irrigation facilities are the best. Canals being the main source of irrigation,(wells being very few), proceed with minor distributaries towards the middle of the village farther into the fields. This reduces the certainty of water supply towards the village interior. This situation accounts for relatively gentle slopes of the component scores surface in this (irrigation-sugar cane-high input) component, and the wage input suface away from larger distributary canals. The Component II (wheat-Bajra-distant field component) explains 30% of the total variance and has high positive loadings on distance,wheat and Bajra. Because, wheat and Bajra show contrast in respect of total production and movement costs, and because, wheat planting frequencies increase with increasing distance, in spite of it that it is a relatively transport intensive crop. Where no reliable irrigation facilities are available, less intensive crops like Bajra are grown. Therefore, wheat and Bajra are seldom co-occupants in the same field and usually do not form a part of same crop location system. The large area of wheat and Bajra in the northern part of the village may be attributed to wide fluctuations in the location of available canal water.

In order to test the hypothesis that, the variations in the irrigation facilities cause field to field variations in cropping pattern, Bajra and sugarcane were chosen, because, firstly, they are both strongly represented in the region and, secondly, the two crops represent a good contrast in required irrigation facilities. All fields in this village are under command of irrigation channels serving them. As Bajra is seldom irrigated, it is postulated that it would occupy those fields which received the least reliable supply of water. Conversly, reliable irrigated lands would be planted in sugarcane.

This experiment explains to some extent the spatial variations in irrigation facility and, also in cropping strategy in the face of uncertainty. In order to measure the quality of irrigation facility, irrigation channel system was treated in a similar way to that of the river systems after R.E. Horton (1945) and A.N. Strahler (1958). A chi-square test was set up to establish whether there was any significant difference between numbers of fields served by channels of different orders which were planted with Bajra and sugar cane. The following conclusions were drawn at a very high level of confidence.

i. Irrigation facilities vary considerably over small areas of some tens of square meters, although all lands may be under command.

ii. This facility at any one location is largely a function of the order of channel and, therefore, indirectly a function of distance from canal inlet into the village lands.

iii. The variations in these facilities cause variations in the crops grown.

iv. A minute adjustment of crop pattern to irrigation facility is apparent. Minimisation of movement is not a discernable factor here.

To summarise the findings of Diighal, irrigation plays a most important role in determinng cropping patterns. The numerous canals in Diighal cause a different adjustment to irrigation facilities from that found in Berwala, where wells provide part of the water for irrigation. There are minor variations in the quality of water in these villages and it is a matter of lifting the water and diverting it to the fields. However, where canal irrigation is used, much greater variations in irrigation facilities are possible. Wheat and Bajra are contrasted crops in respect of total production costs and the costs of movement. Wheat planting frequencies increase with increasing distance. Again wherever irrigation facilities are not reliable, less intensive crops are grown.

Bajra and sugarcane were chosen, because, they were both strongly represented in this region, and also because both have a great contrast in the required irrigation facilities. As Bajra is seldom irrigated, it is postulated that it would occupy those fields which received the least reliable supply of water. Conversly, reliable irrigated lands would be planted in sugar cane. It,therefore,becomes obvious that in Diighal irrigation plays a most important role in determining cropping patterns.

BERWALA

The simple correlation matrix worked out for Berwala by Blaikie defines high co-efficient values linking total irrigation frequency with other variables, and also, linking total canal irrigated cropping frequency with other variables. It seems that irrigation facilities are more important for crop regionalisation than any other factor. However, distance from 'abadi' has several quite high co-efficients and therefore, it also seems an important factor. This conclusion is doubtful, because, firstly, the distance from 'abadi' is highly negatively correlated with the irrigation variables, which means that irrigation facilities are near to the village core in any case.Thus, distance may not be an important locational factor for sugarcane regions, because, irrigation is an absolute essential for sugarcane instead of nearness to the village core. Secondly, other crops which should, according to movement minimisation criterian be grown relatively far from the village core e.g., gram and Bajra are quite unrelated to distance. Finally, crops that should be differentiated according to minimisation of movement are not e.g., gram, Bajra and wheat. The high correlation co-efficient between sugarcane and man/daily wage equivalents is another fact for underlying patterns of the system.

The principal component analysis of Berwala states that the Component I (irrigation-high intensity-sugarcane component) explains 40% of the total variance, and has high positive loadings on input, wages, and canal irrigation, and a negative loading on distance from the 'abadi'. Distance as a variable has a high loading on this component.

Concluding the argument, the irrigation facility is the most important constraint upon the location of sugarcane, because sugarcane absolutely depends upon it. The factor of distance from the village core becomes theoritically important to influence cropping patterns and, input variables according to transport cost. Only when this constraint is absent, either because there is no irrigation at all,or because, there is little variation in irrigation facilities, the factor of distance influences the cropping patterns and input variables.

Component II (gram-Jowar-absence of wheat component) explains 16.5% of the total variance and is characterised by a high positive loading on gram and a negative loading on wheat; as such, it merely demonstrates the antipathy between gram and wheat. As loadings on all irrigation variables are low, it may be assumed that wheat in this component is both irrigated and unirrigated. Here the loading of the distance variable is insignificant. Wheat and gram being well contrasted crops in terms of inputs and transport requirements, if their antipathy had resulted from a movement minimisation criterian, distance would have a higher loading on this component. The factor that drives this component, and bears out the earlier analysis of simple correlation matrix is the common rotation pattern i.e., fallow-wheat, fallow-wheat (again), Bajra-fallow or wheat-fallow, wheat-fallow, wheat-fallow (thrice). Seldom is gram included in wheat dominated rotations.In area with higher positive loadings the predominant rotational pattern is Jowar-gram, fallow-gram, Jowar-gram. Jowar and gram have a moderate affinity in rotational patterns, but are never associated with wheat. Thus, it can be concluded that this component describes rotational patterns of unirrigated lands.

Component III (Bajra-absence of Jowar-unirrigated land component) explains 11% of the total variance and has a high positive loadings on Bajra, and a moderate negative loading on Jowar, this reflects a common rotational pattern including Bajra to the exclusion of Jowar on unirrigated lands. No criteria for minimisation of movements are suggested.

In the analysis of all these three components, minimisation of movements as a criterian in crop location seems quite unimportant. Distances from village core to the fields are small and the isotropic assumption is not fulfilled, because of wide contrast between irrigated and unirrigated lands.

Concluding the findings, Blaikie states that isotropism is severely disturbed by irrigation dominance and, that movement minimisation criteria are unimportant. Well irrigation provides a facility to irrigate a small circular area with a high degree of reliability; while canal irrigation expanding over large areas is variable in the quality of irrigation . Distance as a factor of location in agricultural activity of these villages is reduced to intra-crop input levels in certain crops only.Here water supply is more important than distance factor.

In a valuable and comprehensive landuse study of about 35 villages in Koil Tehsil of the district of Aligarh (Uttar Pradesh) was conducted by **Shafi, M. (1977)** in which attention was focussed on the percentage of different crops in each cropping season, as well as, availablity of irrigation and intensity of doublle cropping.

The following types of zoning patterns were considered in order to assess:

i. The impact of distance from urban settlements on the intensity of landuse and cropping pattern.

ii. The impact of irrigation facilities and the intensity of irrigation on the intensity of landuse, double cropping, and the type of crops to be grown.

Zoning around urban settlement of Koil tehsil of the district Aligarh was carried out by taking railway station as the centre. In this case, nine concentric circular zones at an interval of 1.6 kilometers (one mile) were drawn around the railway station. In each zone data on the percentage of the cultivated land for different groups of crops (food grains, vegetables and cash crops) were collected, including Rabi and Kharif seasons.

Zoning around the canal was carried out and seven elliptical zones were drawn at an interval of 0.4 kilometer (0.25 miles) considering the central line of Ganga Canal as the axis major for determining the impact of intensity of irrigation on the intensity of landuse and cropping pattern.

Zoning on the basis of number of tube wells in the south-western part of tehsil Koil was carried out. In this part of the tehsil, farmers have to rely upon tube-wells for irrigation. To analyse the effect of tube-well irrigation facilities on cropping patterns and double cropping, conical zones with Aligarh railway station as the centre in Tehsil Koil were drawn. Radial lines upto the periphery of eight kilometers from the centre were drawn at equal angles, so that equal area is enclosed in each conical zone.

After evaluating the percentage of cultivated land utilised for each crop group in the corresponding zone, for each zoning pattern, for both the seasons of Rabi and Kharif, the curves were plotted with the ordinate presenting the percentage of crop group and abscissa as the distance from: urban settlements in case of the first type of zoning,distance from the major axis of canal in the second type of zoning and number of tube-wells in each zone in the third type of zoning.

The following conclusions were drawn from the graphs of different zoning patterns:

i. Circular zoning around the urban settlement for all types of crop groups like food grains Rabi, food grains Kharif, vegetables Rabi, vegetables Kharif, pulses and cash crops cultivated land with increasing distance from the settlements does not hold any relationship. The curve trends are in zig-zag form showing fluctuating trend. Taking the example of food grains in Kharif season, the percentage of land utilised in the first zone is 68%, in the second zone 57%, while in the third zone it has increased to 85%. In the last zone which is very far from urban area it is found to be 63% only. Similarly, in case of cash crops in Kharif season, the percentage of land utilised is decreasing with the distance up to Zone-V and then it has increased tremendously.

Study related to double cropping also does not follow Thunen's principle strictly because according to Thunen's principle the intensity of land use should decrease as the distance from the urban settlement increases, while in this case the intensity of landuse with the distance from the settlement does not have any relationship.

ii. In case of the elliptical zoning around the canal, the percentage of landuse under different crop groups, except food grains in Kharif decreases with the increase in the distance from the canal, for example, the percentage of area under cash crops, near The Ganga Canal is 25% and it is 23%, 15%, and 13% in the second, third, and fourth zones respectively. In other words, it decreases with increasing distance from The Ganga Canal.

For double cropping pattern, mathematically it is concluded that the percentage of the land utilisation is invariably proportional to the distance from the availability of water resources used for irrigation. Hence, the Thunen's principle is modofied to - The intensity of land use decreases with increasing distance from the irrigation source rather than from urban settlement.

iii. Zoning on the basis of number of tube-wells was carried out. While supposing the irrigation capacity of the tube-wells as constant, it is observed that the intensity of land utilisation for vegetables and cash crops as well as double cropping decreases with the decreasing number of tube-wells in the zones of equal areas. Kharif crops are not affected by decreasing number of tube-wells in the respective zones because the foodgrains in the kharif season are mainly a function of the type of land and intensity of rainfall within the region.

A comprehensive study of crop landuse was carried out by Shafi, M. for specific villages such as Begpur, Lekhrajpur, Salimpur Mafi and Zorawar of Tehsil Koil of Aligarh district in following manner systematically.

i. The lands surrounding the villages were covered by zones with their settlement as centre.

ii. The total land area under each zone was computed by using graph papers and counting the squares on graph paper on each zone.

iii. The area used for various rabi crops such as food grains, cash crops vegetables, fodder and double cropping were computed for each zone and the percentage of the total area for each crop group was calculated.

iv. In order to visualise the impact of irrigation and double cropping pattern on the distance of urban settlement, the area under double cropping and the total area to be irrigated were computed by using various charts prepared under the landuse survey for specific villages. The following conclusions were drawn :

There is no impact of distance from the village settlement upon the intensity of landuse for various Rabi crops such as food grains, vegetables and fodder does not have any relationship. For food grains, the minimum intensity of land use is found in Zone-V while minimum is in Zone-VI.

The other study on the locational analysis of crop landuse was carried out by **Fakhruddin and Khan, M.F. (1981).** In fact they have tried to assess the analytical validity of Thunen's model in a relatively backward condition of a small administrative unit - Tehsil Unnao of the district Unnao, Uttar Pradesh. The study area is largely drained by River Ganga and receives a mean annual rainfall of about 83.8 centimeters. The whole of the tehsil of Unnao is served by a single town of Unnao, which is in fact a redistributive monofunctional town with a work force of 47.5 percent in tertiary sector. On account of only one town and near uniform physiography, the study area is considered as ideal for the confirmation of concentric zone theory of Von Thunen. Twenty village were picked up for the study of landuse in the region.

On account of stratification involved, the tehsil unnao is divided by the researchers into two sectors. The north-eastern sector enjoys an assured water supply, while the south-western sector experience relatively unstable water supply. This south-western sector is divided into ten concentric semi-circle zones each 1.5 kilometers wide. The north-eastern sector is divided into five elongated zones along the main line of Sarda Canal which runs through the extreme north of tehsil Unnao. The area under different crops was grouped into six heads of wet food crops, dry food crops, pulses, oil seeds, cash crops and, vegetables. The intensity of landuse was measured in terms of percentage share of double cropped area in the net sown area.

The simple linear regression and correlation of the locational patterns of crops with respect to distance from the urban centre and, distance from the source of irrigation lead to the conclusions that :

i. In south-western sector, out of the six crop groups only vegetables and dry food crops have shown a weak tendency for zonal location, while other crop groups are altogether indifferent to the centrifugal and centripetal forces emanating from the urban centre.

ii. In contrast to south-western sector, where distance from urban centre fails to explain locational patterns of the crops, distance from the source of irrigation emerges as a significant determinent of cropping pattern in the north-eastern sector. In this north-eastern sector except oil seeds, with a confused locational behaviour, all other crops along with the intensity of cropping are found strongly related to the distance from the source of irrigation. From these above mentioned findings, Fakhruddin and Khan, reached to the conclusion that in Indian conditions, Von Thunen's model of agricultural location, has, if any, only little relevance and, that in accordance with Shafi's proposition that, the location of crops and intensity of landuse is a function of distance from the source of irrigation (DIS) rather than that of the distance from the urban centre, is valid to a great extent. That was why that those crops which have greater requirements of water are gravitated most to the source of irrigation.

Besides there are a host of other factors involved in the development of cropping pattern in India. Majority of these factors are not economic like crop preferences of different ethnic groups, their differential response to socio-economic and technological innovations, tenancy system, caste and class interactions and, physical factors etc. All these factors should be taken into account for studying a cropping pattern of a region.

On macro-scale a collective study of 137 villages in Jammu district of Jammu and Kashmir was carried out by **Raina, J.L.(1989)** in which the focus of attention was percentage of different crops in each cropping season and the level of intensity of cropping considering double cropped area for this purpose.

Distance impact assessment on the cropping intensity and cropping pattern from urban settlement, and the assessment of impact of irrigation facilities and intensity of irrigation on selection of crops to be grown, and double cropping was made through the following types of zoning patterns.

i. Zoning around the urban settlement of Jammu was made by taking Jammu bus stand as the centre for drawing concentric circles at an interval of 2 kilometers around the periphery of Jammu city upto 24 kilometers into 12 rings of concentric circles. For each zone data for food grains, vegetable crops, cash crops and fodder were collected both for Rabi and Kharif cropping seasons in terms of percentage of cultivated land.

ii. Six semi-elliptical zones at a distance of 2 kilometers along Ranbir Canal taking the central line of the canal as axis major were drawn in order to study the impact of intensity of irrigation on the intensity of landuse and cropping pattern.

iii. For the purpose of the study of the effect of tube well irrigation in south-western part of Jammu district conical zones at an angular difference of 5 degrees, upto a distance 24 kilometers from Jammu bus stand were drawn . Each conical zone was enclosing an area of 28.67 square kilometers.

After evaluating the percentage of area under each crop group in cropping zones for both cropping seasons of Kharif and Rabi, polygraphs were prepared for each type of zoning separately and following conclusions were drawn.

i. Circular zoning around urban settlement: There seems no decline in the percentage of area under cultivation of various crop groups with the increasing distance from the Jammu city. This statement is true for both Rabi and Kharif cropping seasons. Quite similar conclusion is drawn for the intensity of cropping. The percentage of double cropped area does not lie in conformity with the Thunen's principle of - decreasing cropping intensity with increasing distance from the settlement. In case of vegetable cultivation this principle, however, seems to be fitted in but only after Zone-VI from the urban centre.

ii. Semi-elliptical zoning around Ranbir Canal: It is observed that with the exception of food grains of Kharif cropping season, the percentage of area under cultivation of different crop groups in both seasons of Rabi and Kharif decreases with increasing distance from the canal. However, Rabi food grains only in Zone-V show an erratic increase in the percentage of area under cultivation (87 %) which is declined again to its level attained in the Zone-III (63 %). This erratic behaviour as Rana described, is mainly due to local factors. The area under fodder crops of both Rabi and Kharif seasons have a zig-zag trend, thus, no definite trend is established.

In case of double cropping, decreasing trend with increasing distance from the canal is obvious, therefore, it is concluded that the percentage of landuse in double cropping is inversely proportional to the distance from the availability of water resources used for irrigation.

iii. Zoning on the basis of number of tube-wells : Supposing that each tube-well is capable of irrigating an area lying within the bounds of a circumference drawn at a radius of 1.4 kilometers around the tube-well, it was found that intensity of landuse for food grains of both Rabi and Kharif seasons decreases with decreasing number of tube-wells in the zones of equal areas.

However, the trend of fodder for both Rabi and Kharif is not well defined. The pattern of double cropping has a decreasing trend as the availability of amount of sub-soil water decreases.

Summing up the above findings, it can be argued that Von Thunen's model under Indian conditions is not operative fully. The intensity of agricultural landuse do not show any well-defined relationship with varying distances from the settlement. However, it shows an association with varying distance from irrigation facilities.

CHAPTER - VI

TESTING OF VON THUNEN'S MODEL IN GURGAON DISTRICT AT MACRO-LEVEL

A comparision of the model of agricultural location put forward by Von Thunen with the present day agricultural systems of the world, would shows those facts which are the valid reasons for suggesting significant changes in the whole body of the model of agricultural location. Urban places through their market potential for surrounding agricultural hinterland bring about changes in the nature of landuse as well as agricultural production on national, regional and local levels . Availability of irrigation water provides favourable conditions for the production of certain types of crops and a good accessibility may help in promoting the influence of other factors of production.

The present chapter, is therefore, a holistic approach for impact assessment of different factors including distance from the settlements on the intensity of cropping and locational distribution of crops in Gurgaon district of Haryana.

Appendices-III to IX show the distribution of double cropped area and the distribution of crops/crop groups in percentage, while appendices-X to XVI provide the results of statistical analyses for respective zoning schemes.

The following inferences are drawn based upon the selected zoning schemes separetely.

CIRCULAR ZONING AROUND URBAN SETTLEMENT - GURGAON

(a) Cropping intensity and distance from the settlement

The cropping intensity seems to bear a positive relationship with the increasing distance from the settlement of Gurgaon (Fig. 6.1.1A) . It increases with the increasing distance up to a distance of 8 kilometers and then in Zone-V it drops suddenly from 21.27% to 2.43%. After a sharp decline in Zone-V it shoots up again to a level of 36.95% in Zone-VI. The scatter plot with least square line (Fig. 6.1.1B) also exhibits a rising trend of cropping intensity with distance from the city centre. A weak positive correlation of 0.484 with a positive regression coefficient of 1.562 also indicates a weak association between distance and cropping intensity from Gurgaon urban centre. Moreover, the coefficient of determination of 0.2342 indicates that only 23.42 % of the spatial variation in the cropping intensity is explained by distance from the urban settlement Gurgaon. The t-statistic of 1.106 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant both at 0.01 and 0.05 level of significance. It means that the proportionate increase in the cropping intensity is not real and is due to chance.

Hence, the hypothesis, that with increasing distance from the urban settlement, the intensity of cropping decreases, does not hold good in the case of Gurgaon. The hinterland of Gurgaon is reeling under the immense population pressure of Gurgaon and Delhi taken together. The urbanisation is taking place and fertile land in proximity of the city of Gurgaon is transferred to non-agricultural uses by the government agencies like Haryana Development Authority (HUDA) and Haryana Urban Development Corporation (HUDCO). The plots of land earmarked for sectoral development of Gurgaon are casually cultivated and generally remain vacant. This encroachment on fertile agricultural lands largely explains the less intencive agriculture in the vicinity of Gurgaon City.

(b) Area under various categories of crops/crop groups (Rabi and Kharif) and the distance from the settlement

(i) Cereals (Kharif) - During Kharif season of 1993-94, in sample villages around Gurgaon, the main cereal crops were Jowar, Bajra and maize.These three cereals respectively occupied 38.05%, 59.44%, and 2.51% of the total area put to cultivation of cereals in this cropping season.

The area under cereal crops of Kharif season constantly increases from Zone-I upto a distance of 6 kilometers (Zone-III) where it attains a value of 23.59% (Fig. 6.1.2A) and then it decreases up to a distance of 10 kilometers (Zone-V) where it reaches to a level of 13.83% and then rises again upto a distance of 12 kilometers (Zone-VI) with a peak value of 29.22%. The scatter plot with least square line (Fig. 6.1.2B) shows a general increasing trend of cereal distribution with increasing distance from the Gurgaon urban centre. A moderate positive correlation of 0.688 with a positive regression of 1.428 exhibits a moderate positive association between cereals distribution and increasing distance from Gurgaon. However, the coefficient of determination of 0.4733 indicates that only 47.33% of the spatial variation in the distribution of Kharif cereals is explained by distance from the urban settlement. The t-statistic of 1.8981 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is not significant at more than 0.05 level of significance. It means that there exists a weak functional relationship between the distance from the market and area under cereals.

So the apparent increase in area under cereals is not strongly supported and proved true statistically. Hence, the hypothesis that area under cereals, if extensively grown mostly under rainfed cropping, would increase with increasing distance from the urban centre is not accepted in the case of Gurgaon. However, a moderate positive mutual relationship between the cropping intensity and increasing distance from the urban center is observed. This is explained by the fact that Kharif cereal crops like Jowar and Bajra which meet their water requirements largely from summer monsoons find extension in cultivation. Moreover, these crops do not form staple diet of the people, therefore, these crops are paid less attention by the farmers for being grown.

(ii) **Cereals (Rabi)** - The area under cereals of Rabi season shows a rise from Zone-I to Zone-II (Fig. 6.1.2A) and then it is subjected to a decline up to a level of 36.67% in Zone-III. However, from Zone-III onward it is increasing constantly. The scatter plot with least square line (Fig.6.1.7B) exhibits a general increasing trend of Rabi cereals with increasing distance from the urban settlement. A strong positive correlation of 0.719 with a positive regression coefficient of 1.629 also indicates that there exists a general increase in the area of Rabi cereals with increasing distance. Moreover, the coefficient of determination of 0.5170 indicates that 51.70% of the spatial variation in the distribution of Rabi cereals is explained by distance alone from the urban settlement. The t-statistic of 2.069 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at more than 0.05 level of significance. It means that the proportionate increase in the distribution of Rabi cereals is real and is not merely due to chance.

Hence, it may well be concluded that area under cereals increases with increasing distance from the market place is accepted in the case of Gurgaon. It is important to note that besides great population pressure around Gurgaon during Rabi, and better irrigation facilities, area under cereals increases with distance. Since high yielding varieties of wheat require assured irrigation, therefore, it seems the case of intensive commercial grain farming rather than that of extensive agriculture. It should also be noted that wheat invariably a staple diet of the people enjoys a first choice of farmers for being cultivated.

(iii) **Vegetables (Kharif)** - In case of the vegetables of Kharif cropping season (Fig. 6.1.3A) area under cultivation with its peak (13.46%, in Zone-II, decreases to 1.59% in Zone-III, increases marginally to 1.96% in Zone-IV, and then decreases to 1.84% and 1.51% in Zone-V and Zone-VI. In Zone-I, there is no cultivation of vegetables during the Kharif season. The scatter plot with least square line (Fig. 6.1.3B) exhibits an average declining trend which is not clearly perceptible and is rather confusing. A weak negative correlation of -0.289 with a negative regression coefficient of -0.385 suggests that the validity of above statement is questionable. Moreover, the coefficient of determination of 0.0835 indicates that only 8.35% of the spatial variation in the distribution of Kharif vegetables is explained by distance from Gurgaon settlement. The t-statistic of 0.608 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is not significant at both 0.01 and 0.05 levels of significance. It implies that the proportionate distribution of Kharif vegetables is not real and is due to chance.

However, this statistical testing does not necessarily rejects the research hypothesis of decrease in the area under vegetables with increasing distance from the market. One point is to be noted here, that the area in close proximity of the city of Gurgaon is not used for vegetables. Secondly, high demand for vegetables in the markets of Gurgaon and Delhi, together with fairly remunerative prices, is perhaps playing well for the promotion of market gardening even at great distances from these urban centers. This explains why the hypothesis of decreasing area under vegetables is not confirmed statistically.

(iv) **Vegetables (Rabi)** - The area under vegetables of Rabi cropping season from 8.80% in Zone-I decreases to 2.88% in Zone-II. From Zone-II it increases to 3.79% in Zone-III and 4.16% Zone-IV. From Zone-IV it decreases to 1.10% in Zone-V (Fig. 6.1.3A) and increases marginally to 1.13% in Zone-VI. The visual interpretation of the graph states that there is a strong negative relationship between the distribution of Rabi vegetabels and distance from the urban settlement. The scatter plot with least square line (Fig. 6.1.8B) also depicts a steep declining trend in the distribution of Rabi vegetables. A strong negative correlation of -0.816 and a negative regression coefficent of -0.619 further supports the above mentioned statement. Moreover, the coefficient of determination of 0.6659 indicates that 66.59% of the spatial variation in the distribution of Rabi vegetables is alone explained by distance from the urban settlement Gurgaon. The t-statistic of 2.824 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It implies that the proportionate decrease in the distribution of Rabi vegetables is real and is not due to chance.

Hence, the hypothesis that with increasing distance from the city centre the area under Rabi vegetables decreases is accepted. A stronger inverse relationship between distance from the city and area under vegetables owes to differential conditions of production during Kharif and Rabi. Vegetables during Kharif depend receive water through rainfall while Rabi vegetables depend on irrigation primarily by tube-wells. It is observed that villages near the city are more developed and have a good number of tube-wells while villages in the interior of hinterland are not so developed, so far as the development of tube-well irrigation is concerned. Therefore, the Rabi vegetables in addition to the market influence also exhibit impact of irrigation.

(v) **Oil Seeds (Kharif)** - The area under oil seeds of Kharif cropping season shows an alternate increase and decrease as the distance from the market place increases (Fig. 6.1.4A). The scatter plot (Fig. 6.1.4B) along with least square line shows an average tendency of increase with increasing distance. A positive correlation of 0.571 with a positive regression coefficient of 0.314 also points towards the average tendency of increase in the distribution of oil seeds with distance from the urban centre.

However, the coefficient of determination of 0.3260 indicates that only 32.60% of the spatial variation in the distribution of Kharif oil seeds is explained by distance from Gurgaon city. The t-statistic of 1.389 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It implies that the proportionate distribution of Kharif oil seeds is not real and is due to chance.

Hence, the hypothesis that the area under oil seeds increases with increasing distance from the market place is not acceptable. During Kharif season only Til is grown as an oil seed crop. The area under this crop is limited, therefore, personal bias of the farmer's becomes more important than economic influences. This explains, how, inspite of showing a favour to the formulated hypothesis the distribution of Kharif oil seeds is affected by individual farmers decision.

(vi) **Oil Seeds (Rabi)** - The area under Rabi oil seeds, from 20.00% in Zone-I decreases to 8.65% in Zone-II. It increases again to 33.62% in Zone-III and then it decreases continuously in Zone-IV, Zone-V and Zone-VI (Fig. 6.1.4A). The scatter plot with least square line (Fig. 6.1.9B) shows an average increase in the distribution of Rabi oil seeds. However, this graphical representation statistically is not verifiable, A weak positive correlation of 0.410 with a positive regression coefficient of 1.043 further supports the above statement. Moreover, the coefficient of determination of 0.1681 indicates that only 16.81% of the spatial variation in the distribution of Rabi oil seeds is explained by distance from the market. Further, the t-statistic of 0.899 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It implies that the proportionate increase in the distribution of Rabi oil seeds is not real and is due to chance.

The hypothesis that area under oil seeds increases with increasing distance from the city centre in the case of Gurgaon could not be statistically verified and is, therefore, unacceptable. Rabi oil seeds like that of Kharif show a tendency to increase in area away from the regional market. However it does not confirm the hypothesis statistically. In fact economic factors are more powerful which play a crucilal role in greater allocation of area under Rabi oil seeds even in the inner most zones around Gurgaon. Rape seed crop with a high yield and good remunerative market prices induce farmers to make up their mind to go for the cultivation of oil seeds. A gentle rise in the area of oil seeds with distance is more attributed to a relatively high concentration of this crop in the inner zones. Therefore, economic motives seem to be the potent factors in the location of Rabi oil seeds.

(vii) **Fodder (Kharif)** - The area occupied under the fodder crops of Kharif cropping season (Fig. 6.1.5A) from Zone-I to Zone-VI decreases gradually except only in one case of Zone-II. In Zone-II, the area under fodder crops shows a low figure of 5.77% as compared to 16.00% of Zone-I and 11.25% of Zone-III. The scatter plot with least square line shows a gradual decline in the area put to fodder cultivation with increasing distance from the city centre (Fig. 6.1.5B). A negative strong correlation of -0.799 and a negative regression coefficient of -1.019 supports the fact that their is an inverse relationship between area under fodder and distance from the city of Gurgaon.

Moreover, the coefficient of determination of 0.6384 indicates that 63.84% of the spatial variation in the distribution of Kharif fodder is explained alone by distance from the urban settlement. The t-statistic of 2.653 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It implies that the proportionate distribution of Kharif fodder is real and is not due to chance.

Hence, the hypothesis that area under fodder crops decreases with increasing distance from the market is acceptable. Since the demand for milk and milk products generally shows a declining trend with distance from the market, this fact is translated in the form of declining trend of fodder cultivation. Moreover, being a low cost and bulky product, it becomes uneconomic to produce fodder at distant locations with respect to market places. This explains why the hypothesis regarding fodder distribution is accepted.

(viii) **Fodder (Rabi)** - The area under Rabi fodder crops shows an alternate decrease and increase from Zone-I to Zone-VI and no specific trend is established through visual interpretation (Fig. 6.1.5A). The scatter plot with least square line (Fig. 6.1.10B) exhibits a continuous decline in the distribution of Rabi fodder. A strong negative correlation of -0.774 with a negative regression coefficient of -1.033 further supports the above mentioned statement of declining trend in the distribution of Rabi fodder with respect to distance from the city centre.

Moreover, the coefficient of determination of 0.5991 indicates that 59.91% of the spatial variation in the distribution of Rabi fodder is alone explained by distance from the urban settlement. The t-statistic of 2.444 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. Hence, the hypothesis that area under fodder crops decreases with increasing distance from the city centre is acceptable for the same reasons mentioned in case of Kharif fodder.

(ix) **Pulses (Kharif)** - The area under the pulses of Kharif cropping season is subjected to a constant decrease with increasing distance from the urban settlement (Fig. 6.1.6A) There is a slight rise from 0.98% (Zone-III) to 1.96% (Zone-VI) in the area under pulses.

The scatter plot with least square line (Fig. 6.1.6B) also shows a steep declining trend in the area put to the cultivation of pulses in Kharif cropping season. A strong negative correlation of -0.843 with negative regression coefficient further supports the above statement. Moreover, the coefficient of determination of 0.7106 indicates that 71.06% of the spatial variation in the distribution of Kharif pulses is explained by distance alone from the urban settlement. The t-statistic of 3.138 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It implies that the proportionate decrease in the distribution of Kharif pulses is real and is not due to chance.

Hence, the hypothesis, that area under the pulses of Kharif cropping season increases with increase in distance from the urban settlement is rejected. Pulses being less preferred crops in the study area are generally avoided by the farmers for being cultivated. However, they are grown mostly for home consumption. Despite low remunerative value pulses occupy the prime land of inner zones. It tells about that to some extent pulses are also grown for commercial reasons. A high demand for pulses in Gurgaon and Delhi is perhaps the reason for this type of locational behaviour of Kharif pulses.

(x) **Pulses (Rabi)** - The area under the pulses of Rabi cropping season is showing a mixed trend (Fig. 6.1.6A). In Zone-I its value is maximum (5.60%), in Zone-II it decreses (1.92%), then in Zone-III it increases again (2.44%), in Zone-IV it is again decreased (0.49%). From Zone-IV to Zone-VI it gradually increases from 0.96% to 1.04%. The scatter plot (Fig. 6.1.11B) with least square line shows a perceptible decrease in the distribution of pulses. A strong negative correlation of -0.791 along with a negative

Locational Patterns of Cropping And Distance Around Gurgaon City
(1993-94)

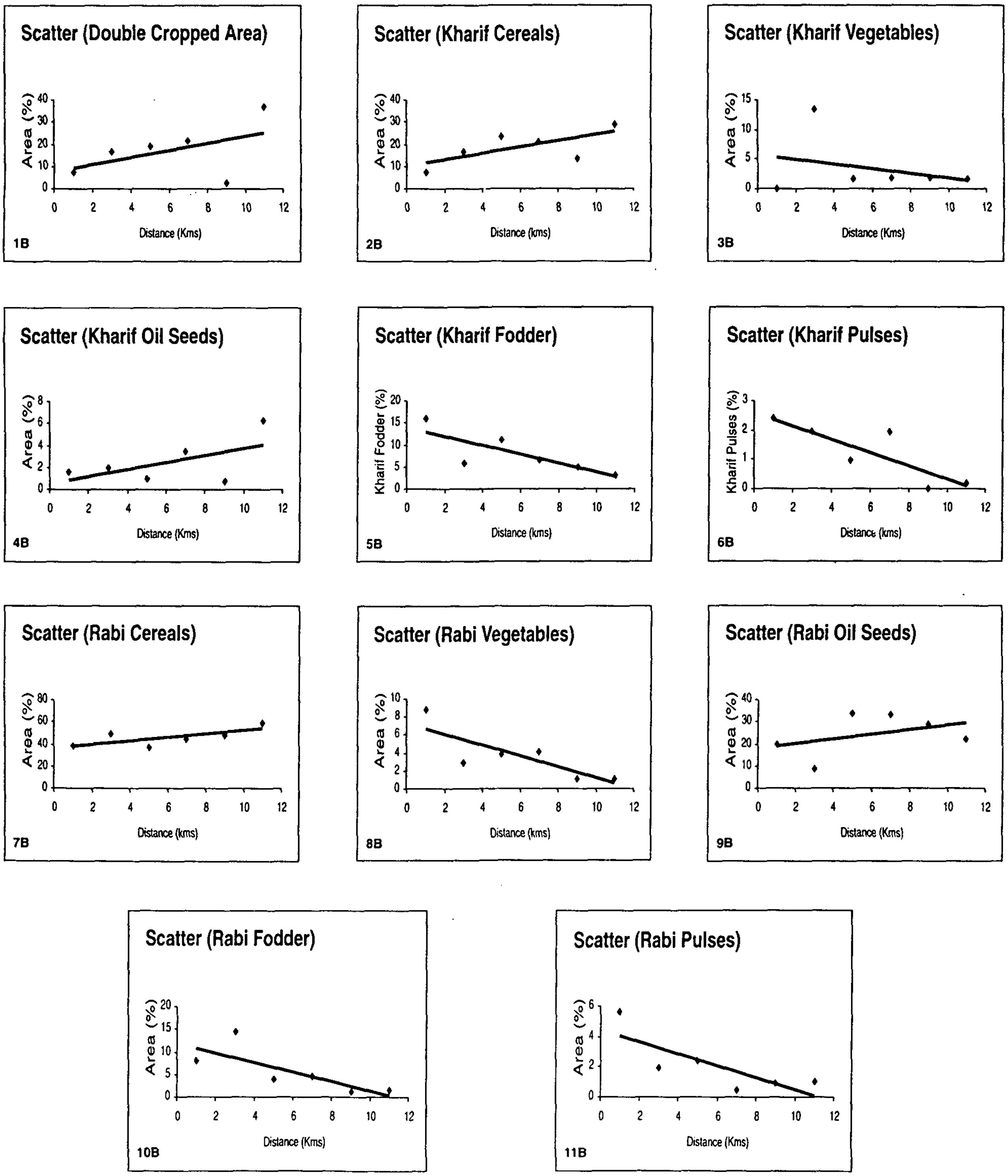
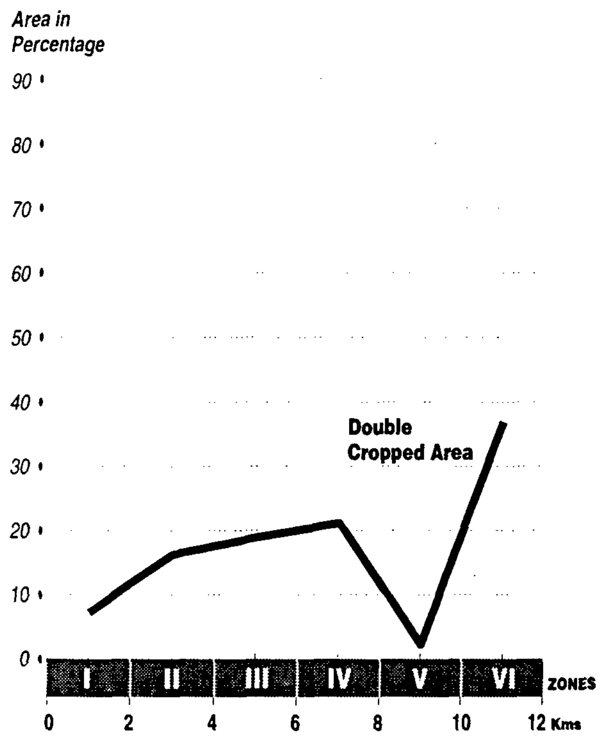


Fig. 6.1

INTENSITY OF CROPPING

Circular Zoning Around Gurgaon City
(1993-94)

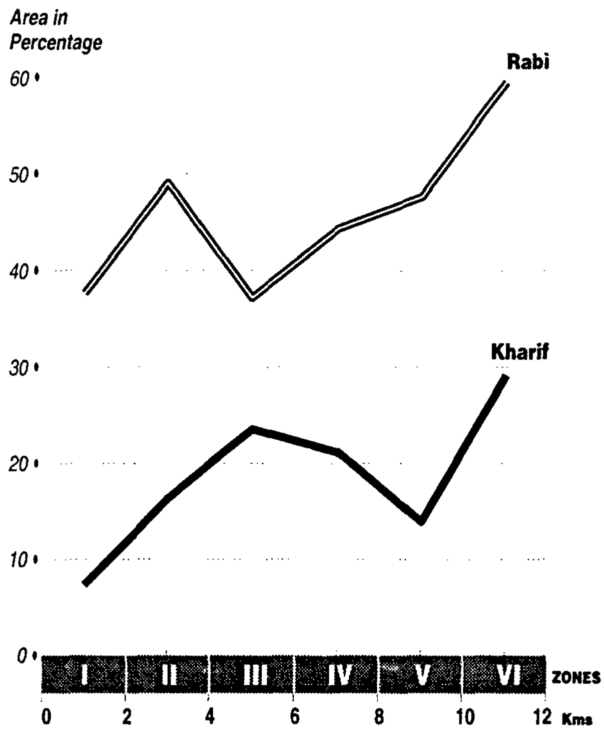
Fig-6.1.1A



CEREAL CROPS

Circular Zoning Around Gurgaon City
(1993-94)

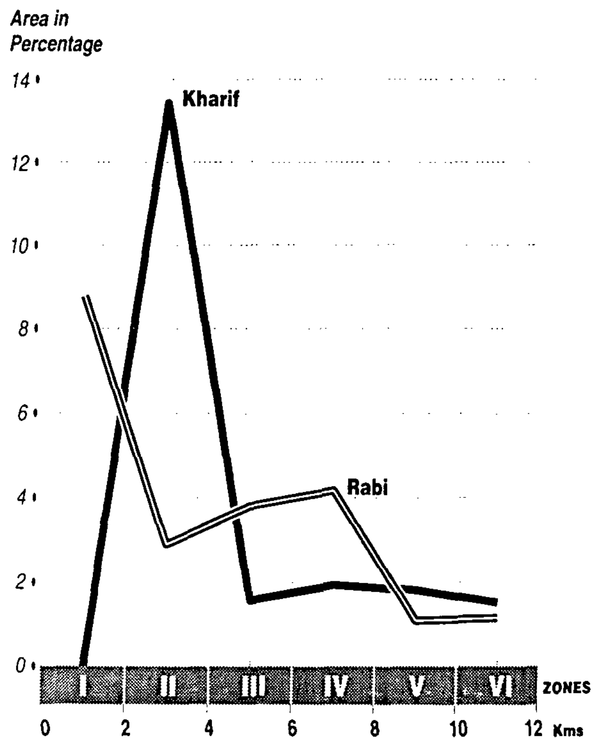
Fig-6.1.2A



VEGETABLES

Circular Zoning Around Gurgaon City
(1993-94)

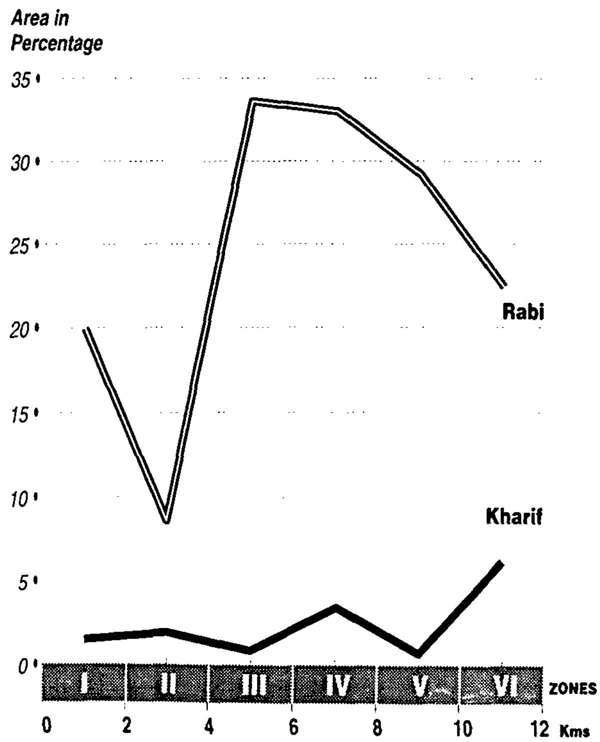
Fig-6.1.3A



OIL SEEDS

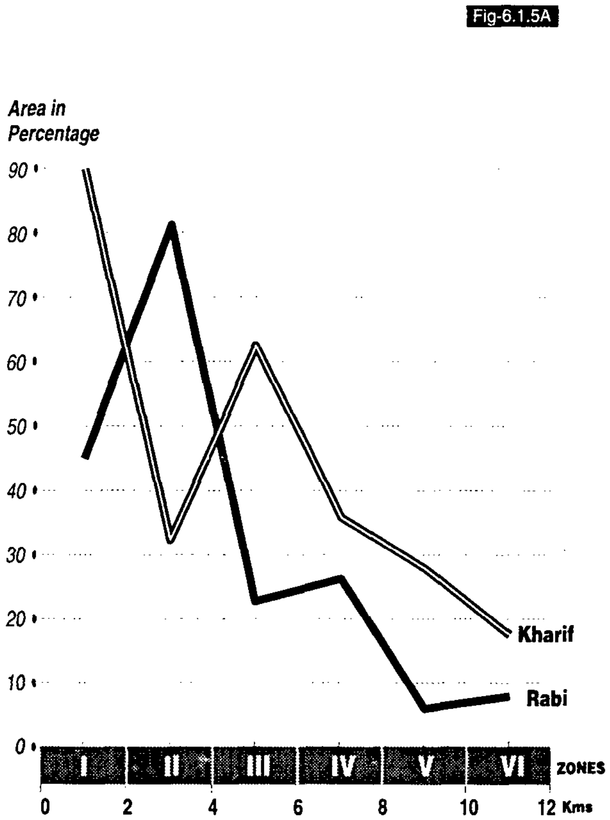
Circular Zoning Around Gurgaon City
(1993-94)

Fig-6.1.4A



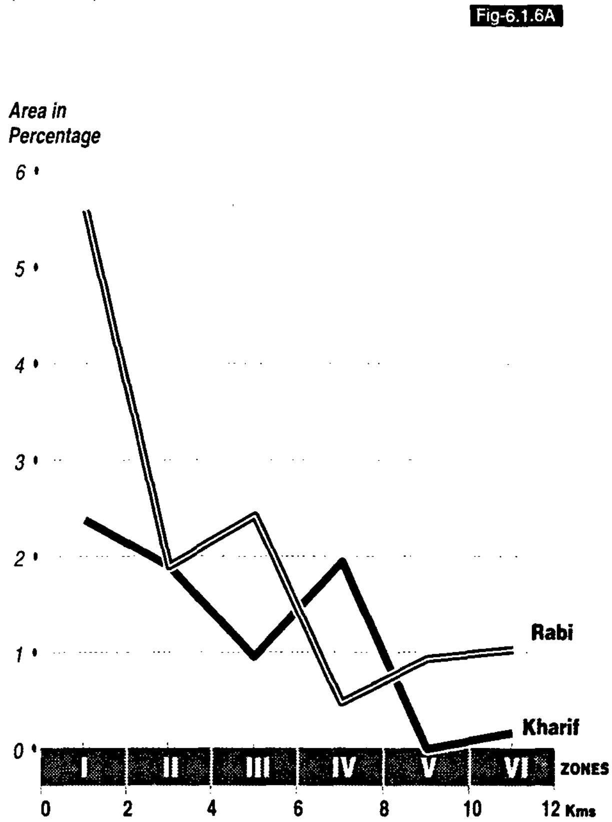
Fodder

Circular Zoning Around Gurgaon City
(1993-94)



Pulses

Circular Zoning Around Gurgaon City
(1993-94)



regression coefficient of -0.395 supports the above mentioned statement. Moreover, the coefficient of determination of 0.6257 indicates that 62.57% of the spatial variation in the distribution of Rabi pulses is explained alone by distance from the urban settlement. The t-statistic of 2.590 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It implies that the proportionate decrease in the distribution of Rabi pulses is real and is not due to chance.

Hence, the hypothesis, that area under the pulses of Rabi cropping season increases with increasing distance from the market place, is not acceptable. The distribution of pulses (Appendix-III) shows that they occupy large area in the inner zones. This explains that pulses around Gurgaon city are grown for commercial purposes, and therefore, a reverse trend of distribution is observed rather than that perceived in the postulate.

In case of the zoning around Gurgaon the hypotheses which were proved were about the Rabi cereals, Rabi vegetables and fodder crops of both Rabi and Kharif cropping seasons. The rest of the crops/crop groups however, could not validate their respective hypotheses.

CIRCULAR ZONING AROUND URBAN SETTLEMENT - NUH

(a) Cropping intensity and distance from the settlement

The intensity of cropping around the city of Nuh goes on decreasing right from Zone-I to Zone-IV, thereafter it increaes in Zone-V as well as in Zone-VI (Fig. 6.2.1A). The scatter plot with least square line (Fig. 6.2.1B) depicts that there is an average declining trend in the intensity of cropping with increasing distance from the township of Nuh. However, a weak negative correlation of -0.403 and a negative regression coefficient of -1.181 do not support the above mentioned statement. Moreover, the coefficient of determination of 0.1624 indicates that only 16.24% of the spatial variation in the cropping intensity is explained by distance from the Nuh settlement. The t-statistic of 0.8815 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It implies that the proportionate distribution of double cropped area is not real and is due to chance.

Hence, the hypothesis that intensity of cropping decreases wilth increasing distance from the urban settlement does not hold good in the case of Nuh. The apparent, statistically insignificant decline in cropping intensity with increasing distance from Nuh, reveals that comparatively more tub-well and canal irrigation facilities in the outer zones (Appendix-IV) have partially arrested the hypothesised steep decline of the cropping intensity in the case of Nuh. However, it seems to have have a close covariance with the pattern of intensity of irrigation. It increases in zones in response to the percentage of irrigated area.

(b) **Area under various crop groups and distance from the settlement**

(i) **Creals (Kharif)** - During Kharif season of 1993-94 in sample villages around Nuh, there were only two main cereal corps eg., Jowar which occupied 50.17% and Bajra which occupied 47.53% of total area put to the cultivation of cereals.

The line graph for the area under cereals in the Kharif cropping season (Fig. 6.2.2A) shows no specific trend. From Zone-I to Zone-II it decrease, and then it incerases between Zone-II and Zone-IV. In Zone -V again there is a decline in the area under cereals. From Zone -V to Zone-VI the curve rises again. The scatter plot with least square line (Fig. 6.2.2B) also shows an average trend which is rather confusing. A moderately high correlation of 0.652 and a regression coefficient of 1.592 fail to prove any signifiant relationship between the distribution of Kharif cerals and distance from Nuh. Moreover, the coefficient of determination of 0.4251 indicates that 42.51 % of the spatial variation in the distribution of Kharif cereals is explained by distance from the urban settlement. The t-statistic of 1.721 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It implies that the proportionate increase in the distribution of Kharif cereals is not real and is due to chance.

Hence, the hypothesis that the area under cereal crops will increase with increasing distance from the city is not acceptable. Jowar and Bajra are dry crops, and require less amount of water, therefore, during Kharif cropping season, rainfall from south-west monsoons holds the key in determining the cropping pattern on macro-level. It is quite likely that high spatial variability of rainfall is more answerable for the increasing trend of Kharif cereals around Nuh. However, the existing increasing trend with weak statistical support points out towards the extensification of Kharif cereals.

(ii) **Cereals (Rabi)** - During Rabi cropping season of 1993-94 around Nuh, among cereals only three crops were dominating the scene. Wheat, which ranked I occupied 75.71%, gram ranked II occupied 16.01%, and barley which ranked III, occupied 8.29% of the total area put to the cultivation of Rabi cereals.

The area under cereals of Rabi cropping season from Zone-I to Zone-VI is subjected to a sequence of increase, decrease, decrease, increase, and decrease (Fig. 6.2.2A). The scatter plot with least square line showing an average increasing trend which is rather confusing and imperceptible (Fig. 6.2.7B).A moderately high positive correlation of 0.634 with a positive regression coefficient of 1.452 seems to be quite ineffective in confirming the respectively formulated hypothesis, when the coefficient of determination of 0.4020 indicates that only 40.20% of the spatial variation in the distribution of Rabi cereals is explained by distance from the Nuh settlement. The t-statistic of 1.638 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is not significant at even more than 0.05 level of significance. It implies that the proportionate distribution of Rabi cereals is not real and is due to chance.

Hence, the hypothesis that area under cereal crops would increase with increasing distance from the city is not significantly valid for Nuh on statistical grounds.

(iii) **Vegetables (Kharif)** - The percentage of area under vegetables of Kharif cropping season (Fig. 6.2.3A) is showing a constant downward trend until Zone -V where it is subjected to a slight increase (0.99%). In Zone-VI again it has declined. In fact in Zone-IV the area under vegetables is abnormally low (0.06%) which can be attributed to a very low intensity of irrigation (10.41%) in this zone. The scatter plot with least square line (Fig. 6.2.3B) shows a perceptible declining trend with increasing distance. A strong negative correlation of -0.886 with a negative regression coefficient of -0.329 strongly supports the above mentioned statement. Moreover, the coefficient of determination of 0.7850 indicates that 78.50 % of the spatial variation in the distribution of Kharif vegetables is alone explained by distance from the urban settlement. The t-statistic of 3.816 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.01 level of significance. It implies that the proportionate decrease in the distribution of Kharif vegetables is real and is not due to chance.

The hypothesis that area under vegetables will decrease with increasing distance from the city is, therefore, acceptable in the case of Nuh. The influence of market place of Nuh on vegetable production rapidly decreases with increasing distance specially beyond Zone-III, for reasons that the villages located nearby Nuh are able to meet out most of the vegetables requirements of this town of a small population. In addition due to the perishability and extra transpotation costs, vegetables are not prefered to be grown at a farther distance away from the urban settlement.

(iv) **Vegetables (Rabi)** - The percentage of area under vegetables of Rabi cropping season is showing a general decreasing trend (Fig. 6.2.3A) .In Zone-II it is decreases, in Zone-III, it increases and then in Zone-IV and Zone-V it is decreased and again it is increased in Zone-VI. The peak in Zone-III, can be justified on account of high intensity of irrigation in this Zone (32.63%). Similary in Zone -VI the intensity of irrigation is again high (48.87%). The scatter plot with least square line (Fig. 6.2.8B) indicates a declining trend in the distribution of Rabi vegetables. A strong negative correlation of -0.797 with negative regression coefficient of -0.779 confirms the above mentioned statement. Moreover, the coefficient of determination of 0.6352 indicates that 63.52% of the spatial variation in the distribution of Rabi vegetables is alone explained by distance from the urban settlement. The t-statistic of 2.635 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It implies that the proportionate distribution of Rabi vegetables is real and is not due to chance.

The hypothesis that the area under vegetables will decrease with increasing distance from the city is, therefore, accepted in the case of Nuh for the same resons mentioned above in case of Kharif vegetables.

(v) **Oil Seeds (Kharif)** - The area under oil seeds of Kharif cropping season with increasing distance from the city of Nuh, from Zone-I to Zone-VI is subjected to a sequence of, decrease, increase, decrease, increase and increase (Fig. 6.2.4A). The scatter plot with least square line (Fig. 6.2.4B) shows an apparent increasing trend. However, this trend is not supported by statistical figures, like a weak positive correlation of 0.461 and a positive regression coefficient of 0.083. Moreover, the coefficient of determination of 0.2125 indicates that only 21.25 % of the spatial variation in the distribution of Kharif oil seeds is explained by distance from the urban settlement. The t-statistic of 1.039 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It means that the proportionate increase in the distribution of Kharif oil seeds is not real and is due to chance.

Hence, the hypothesis that area under oil seeds of Kharif will increase with increasing distance from the city is unacceptable in the case of Nuh. During Kharif season very small area is deovted to the cultivation of Til, which is the main oil seed produced in this season. Its cultivation is highly limited, hence, its distribution and locational pattern is greatly influenced by the personal considerations of the farmer than by economic forces. Therefore, its location is liable to a high degree of subjectivity.

(vi) **Oil Seeds (Rabi)** - The area put to the cultivation of oil seeds in Rabi cropping season is subjected to a constant increase from Zone-I to Zone-VI, except in the case of Zone-IV where it has declined almost to a level of Zone-II. In fact, the percentage of area under oil seeds in Zone-III is exceptionally high (Fig. 6.2.4A). The scatter plot with least square line (Fig. 6.2.9B) exhibits an average increasing trend which is much confusing as represented by a weak correlation of 0.575 and a regression coeffiecient of 1.017. However, the coefficient of determination of 0.3306 indicates that only 33.06 % of the spatial variation in the distribution of Rabi oil seeds is explained by distance from the urban settlement. The t-statistic of 1.399 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It implies that the proportionate distribution of Rabi oil seeds is not real and is due to chance.

Hence, the hypothesis that area under oil seeds increases with increasing distance from the city can not be accepted in the face of weak statistical support. In every zone of production around Nuh, the distribution of Rabi oil seeds ranks second after Rabi cereals. This shows that for economic reasons Rabi oil seeds are the most important crops after cereals in the study area. The observed rising trend of the distribution seems to bear a sort of relationship which is stated in the respective postulate. High yield and high market price for oil seeds have encouraged a relatively high concentration of these crops even in the inner zones around Nuh. As a consequence to this, the distribution gradient of Rabi oil seeds has become gentle.

(vii) **Fodder (Kharif)** - The area under fodder crops of Kharif cropping season is showing a decline from Zone-I to Zone-III, and from

Zone-III to Zone-IV it shows a constant increase. (Fig. 6.2.5A). The scatter plot with least square line (Fig. 6.2.5B) shows a declining trend in the distribution of fodder crops. A strong negative correlation of -0.738 and a negative regression coefficient of -2.009 also confirms the above statement. Moreover, the coefficient of determination of 0.5446 indicates that 54.46% of the spatial variation in the distribution of Kharif fodder is alone explained by distance from the urban settlement. The t-statistic of 2.189 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It implies that the proportionate decrease in the distribution of Kharif fodder is real and is not due to chance.

The hypothesis that area under fodder crops will decrease with increasing distance from the city centre is true and is acceptable. Since, the demand curve for dairy products degenerates sharply out wards from the city, the cultivaiton of fodder also decreases away from the market place. Moreover, it becomes less profitable to grow a low value-high bulk crop like fodder at distant locations.

(viii) **Fodder (Rabi)** - The area under fodder crops of Rabi cropping season is also showing a constant decline upto Zone-III, thereafter, it increases constantly upto Zone-VI (Fig 6.2.5A). The scatter plot with least square line (Fig. 6.2.10B) also exhibits a declining trend. A negative moderate correlation of -0.680 with a negative regression coefficient of -1.845 states that there is a declining trend in the distribution of fodder. The coefficient of determination of 0.4624 which indicates that only 46.24% of the spatial variation in the distribution of Rabi fodder is explained by distance from the urban settlement. The t-statistic of 1.853 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It shows that there exists a weak functional relationship among the existing distribution of Rabi fodder and distance from the market place.

Hence, the hypothesis that the area under fodder crops of Rabi cropping season declines with increasing distance from the city centre can be accepted with some reservations. The diminishing demand with increasing distance for dairy products from the market place coupled with economic counter productivity if a low value-high bulk crop like fodder being grown at distant locations are perhaps the possible causes for declining distribution of fodder with increasing distance from the market place.

(ix) **Pulses (Kharif)** - The area under pulses of Kharif cropping season with increasing distance from the city of Nuh seems not to bear any defined relationship (Fig. 6.2.6A). In Zone-I the area under pulses is 2.14%, while in Zone-II, Zone-III, and Zone-IV, there is no area devoted to the cultivation of pulses. In Zone-V it is 0.21% while in Zone-VI it is 0.08%. The scatter plot with least square line (Fig. 6.2.6B) shows a successive decline in the distribution of Kharif pulses from the city centre. This declining trend, though, to some extent is supported by a negative correlation of -0.605 and a negative regression coefficient of -0.138 could not be confirmed in the light of the coefficient of determination of 0.3660, which indicates that only 36.60% of the spatial variation in the distribution of Kharif pulses is explained by distance from the urban settlement. The t-statistic of 1.520 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It implies that the proportionate decrease in the distribution of Kharif pulses is not real and is due to chance.

Hence, the hypothesis that area under pulses of Kharif season increases with increasing distance from the city is not acceptable in the case of Nuh. Pulses being the less preferred crops are grown in Zone-I, V and VI only, therefore, the selection of location for pulses to be grown is influenced by a high degree of subjectivity in the decision making of the farmers. These pulses are grown generally for home consumption.

(x) **Pulses (Rabi)** - The area under pulses of Rabi cropping season with increasing distance from the city of Nuh seems not to bear any relationship. From Zone-I it increases in Zone-II, decreases in Zone-III, increases in Zone-IV, decreases in Zone-V, and lastly increases in Zone-VI (Fig. 6.2.6A). The scatter plot with least square line (Fig. 6.2.11B) shows an average declining trend which is supported by a negative correlation of -0.610 and a negative regression coefficient of -0.298. However, these statistical values are not confirmed statisticaly. The coefficient of determination of 0.3721 indicates that only 37.21% of the spatial variation in the distribution of Rabi pulses is explained by distance from the urban settlement. The t-statistic of 1.538 of the regression coefficient with

Locational Patterns of Cropping And Distance Around Nuh City
(1993-94)

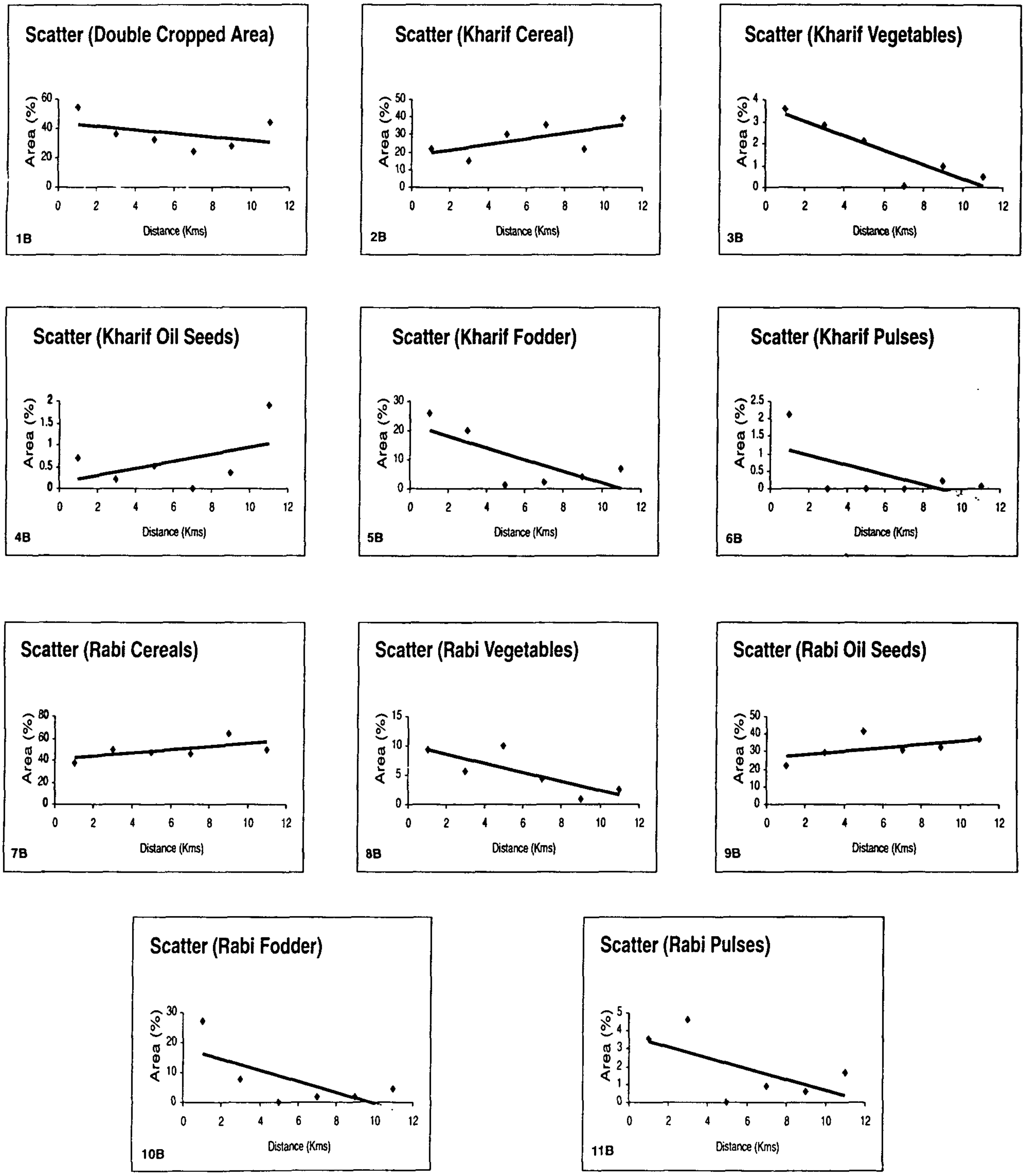
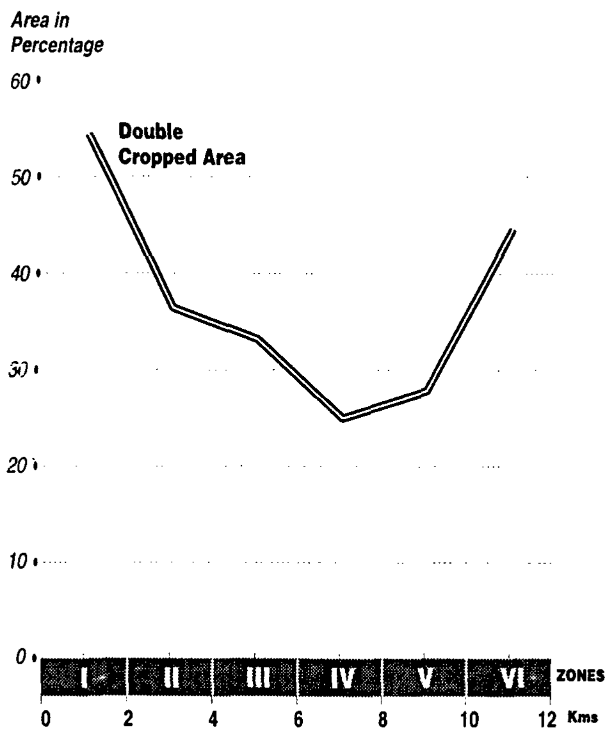


Fig. 6.2

INTENSITY OF CROPPING

Circular Zoning Around Nuh City
(1993-94)

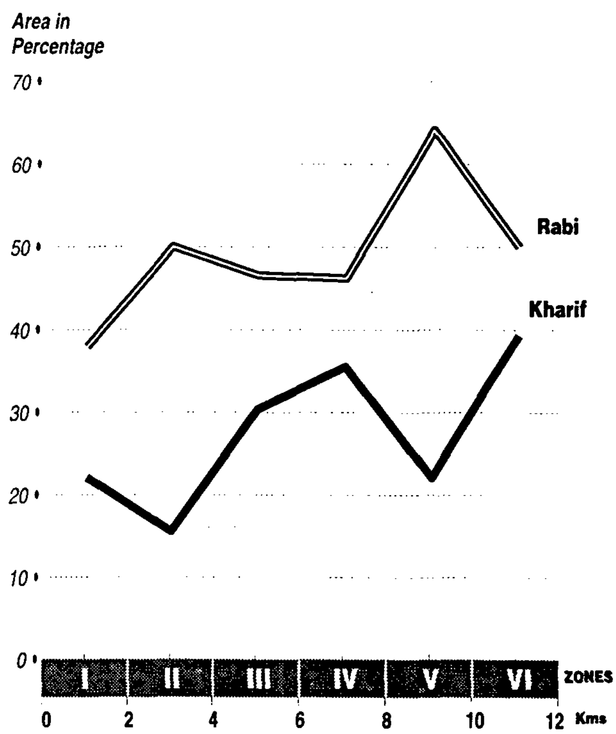
Fig-6.2.1A



CEREAL CROPS

Circular Zoning Around Nuh City
(1993-94)

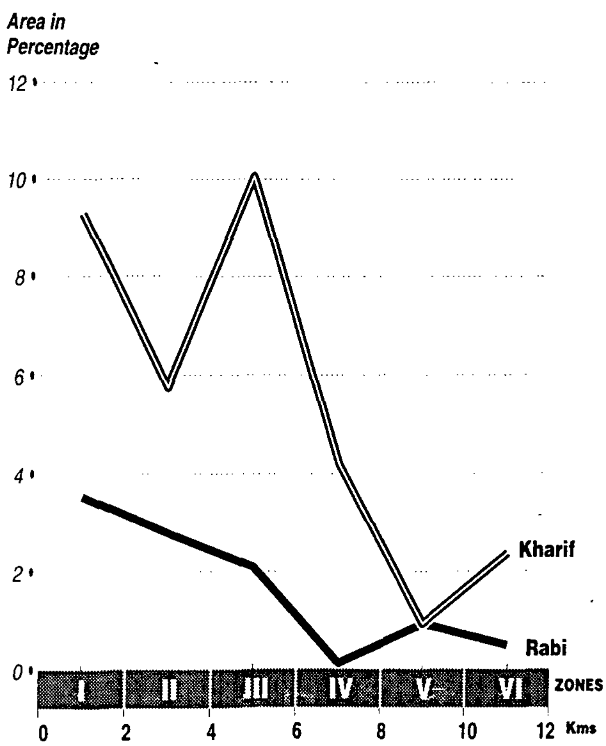
Fig-6.2.2A



VEGETABLES

Circular Zoning Around Nuh City
(1993-94)

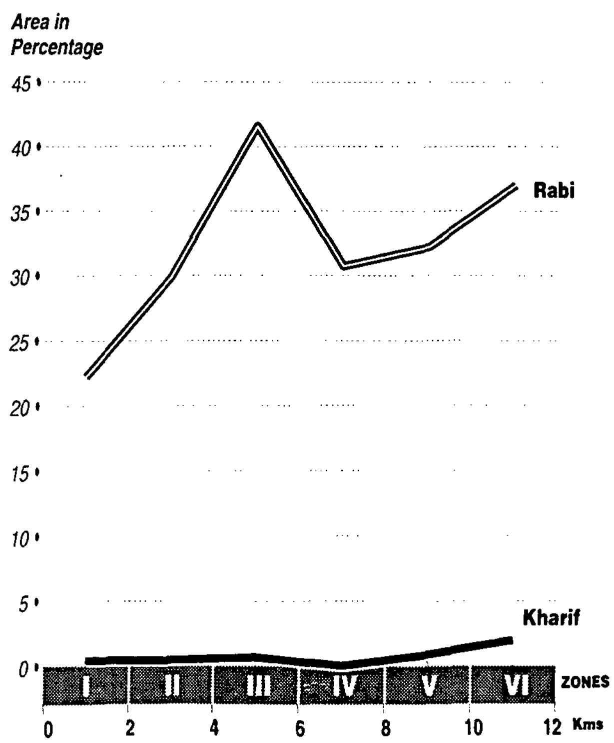
Fig-6.2.3A



OIL SEEDS

Circular Zoning Around Nuh City
(1993-94)

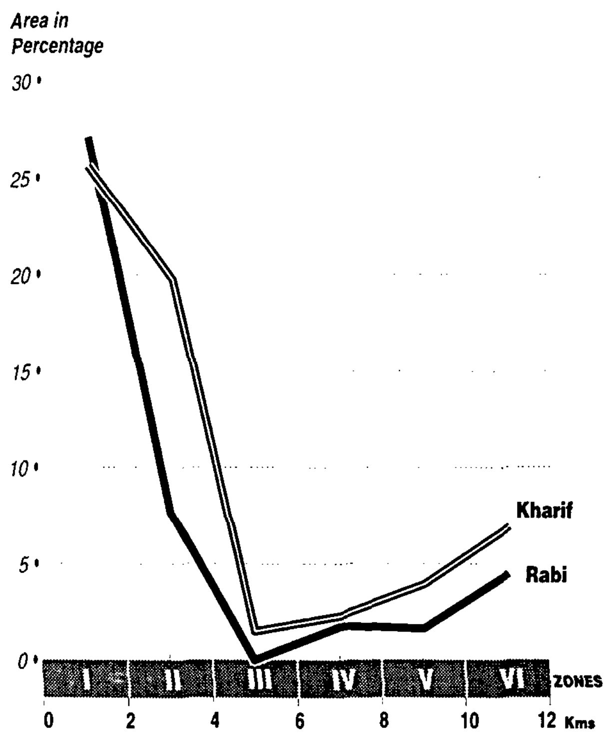
Fig-6.2.4A



FODDER

Circular Zoning Around Nuh City
(1993-94)

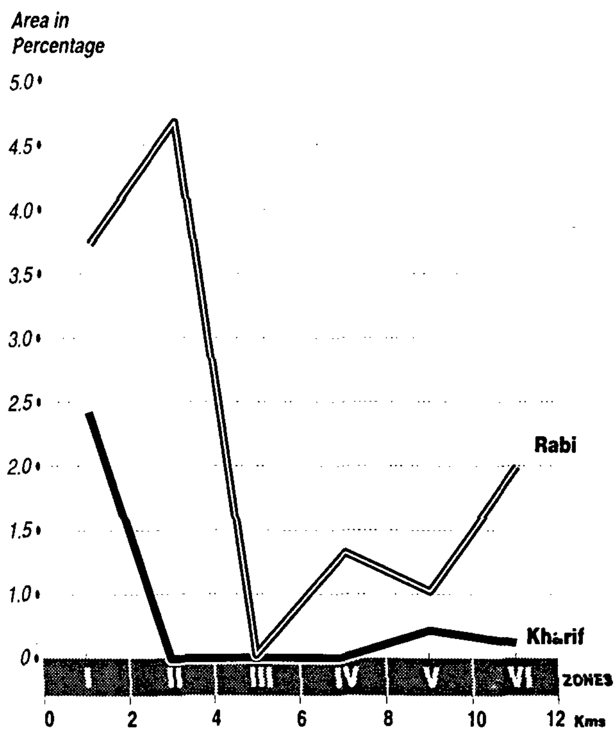
Fig-6.2.5A



PULSES

Circular Zoning Around Nuh City
(1993-94)

Fig-6.2.6A



4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It implies that the proportionate distribution of Rabi pulses is not real and is due to chance.

Hence, the hypothesis that area under pulses of Rabi season will increase with increasing distance from the city can not be accepted in the case of Nuh for the same reasons mentioned above in case of Kharif pulses. However, the location of pulses in the inner zones explains that pulses are also grown to some extent for economic and commercial reasons.

In case of circular zoning around Nuh the hypotheses which were proved true regarding vegetable crops of Rabi and Kharif cropping seasons as well as fodder crops of Kharif season only. The rest of all other crops/crop groups could not came true according to the hypotheses formulated.

OBLONGED ZONING ALONG DELHI-JAIPUR RAILWAY

(a) Cropping intensity and distance from the railway

A close examination of the curve of cropping intensity along the railway line (Fig. 6.3.1A) exhibits a decline upto Zone-III, thereafter it shows a little increase in Zone-IV, and then, it climbs high up to a level of 41.72% in Zone-V then again declines in Zone-VI up to a level of 16.09%. The high figure of cropping intensity in Zone-V may be attributed to high intensity of irrigation (95.71%) for the same zone. The scatter plot (Fig. 6.3.1B) with least square line shows a general declining trend which is imperceptible and is rather confusing. A weak negative correlation of -0.388 and a negative regression coefficient of -1.898 fail to explain a significant degree of relationship with certainity. Moreover, the coefficient of determination of 0.1505 indicates that only 15.05% of the spatial variation in the cropping intensity is explained by distance from the railway. The t-statistic of 0.843 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It means that the proportionate decrease in the cropping intensity is not real and is due to chance.

The hypothesis that intensity of cropping decreases with increasing distance from the railway is, therefore, not accepted. It shows that accessibility from railway has nothing to do with the pattern of cropping intensity, however, other factors like assured water supply and fertility of soil are more important in determining the pattern of intensity of cropping.

(b) Area under various categories of crops/crop groups (Kharif and Rabi) and the distance from the railway

(i) **Cereals (Kharif)** - During the Kharif cropping season of 1993-94, in the sampled villages, along Delhi-Jaipur railway only two crops Bajra and Jowar were significant. Bajra occupied 85.64% while Jowar occupied 11.33% of the area put to the cultivation of Kharif cereals. The remaining area was occupied by other Kharif crops.

The area under cereal crops of Kharif cropping season decreases continuosly from Zone-I to Zone-IV. (Fig. 6.3.2A). In Zone-V it increases to 18.40%, then decreases to 13.04% in Zone-VI. The scatter plot with least square line (Fig. 6.3.2B) shows a declining trend of the distribution of Kharif cereals with increasing distance from Delhi-Jaipur railway. A strong negative correlation of -0.721 with a negative regression coefficient of -2.894 stand ineffective even where, the coefficient of determination is 0.5184 which indicates that 51.84% of the spatial variation in the distribution of Kharif cereals is explained by distance from the railway. The t-statistic of 2.100 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient though, insignificant at even 0.05 level of significance, yet it lies very near to the critical value. It means that the proportionate decrease in the distribution of Kharif cereals is perhaps not real and is due to chance.

Hence, the hypothesis that area under cereals increases with increasing distance from the railway could not be proved statistically in the case of Kharif cereals. It shows that accessibility from a railway does not exert much influence on the distribution of Kharif cereals, since in semi-arid conditions, availability of water along with nature of the soil cover plays more important role in the determination of locational patterns of Kharif cereals rather than the proximity to a line of communication.

(ii) **Cereals (Rabi)** - The area under cereals of Rabi cropping season with a slight decrease in the Zone-II, goes on increasing up to Zone-IV (Fig. 6.3.2A). In Zone-V it attains a lowest value of 57.66%. In Zone-VI it again increases to 94.35%. This decrease in the Zone-V is perhaps due to the fact that a relatively high percentage of cultivated area is devoted to oil seeds in the same zone. The scatter plot (Fig. 6.3.7B) with least square line exhibits an average increasing trend which is rather confusing.The positive correlation of 0.505 with a positive regression coefficient of 2.460 are not much effective in explaining the distribution of Rabi cereals with increasing distance from the railway. Moreover, the coefficient of determination of 0.2550 indicates that only 25.50% of the spatial variation in the distribution of Rabi cereals is explained by distance from railway. The t-statistic of 1.171 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It implies that the apparent proportionate increase in the distribution of Rabi cereals is not real and is due to chance.

Hence, the hypothesis that the area under cereals of Rabi season increases with increasing distance from the railway is not acceptable. It explains that there are some other factors which are more important than accessibility for making this hypothesis to be validated. In arid climatic conditions of the study area particularly during Rabi season irrigation becomes much important for cropping. The observed distribution of Rabi cereals seems to have a close association with the intensity of irrigation (Appendix-V) rather than with the accessibility from railway.

(iii) Vegetables (Kharif) - The area under vegetables of Kharif cropping season shows a continuously downward trend upto a distance of 8 kilometers (Zone-IV). In Zone-V, the area under vegetables is comparatively very high (3.07%). In Zone-VI, there is no area under the cultivation of vegetables. (Fig. 6.3.3A). The high figure for Zone-V corresponds with the high intensity of irrigation (95.71%) in the same zone (Appendix-V). The scatter plot with least square line (Fig. 6.3.3B) describes an average declining trend which is rather much imperceptible. A negative very weak correlation of -0.126 with a negative regression coeffecient of -0.039 confirms the above statement. Moreover, the coefficient of determination of 0.0159 indicates that only 1.59% of the spatial variation in the distribution of Kharif vegetables is explained by distance from the railway. The t-statistic of 0.255 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It implies that the proportionate distribution of Kharif vegetabels is not real and is due to chance.

Hence, the hypothesis that area under Kharif vegetables decreases with increasing distance from the railway is, therefore, not accepted. As a matter of fact the production of vegetables largely depends upon assured water supply, fertility of the soil and ready nearby market facilities because, it is a perishable commodity. This explains, why a relationship between distance from railway and the distribution of Kharif vegetables was not stablished in accordance with the respective postulate.

(iv) **Vegetables (Rabi)** - The percentage of area under the vegetables of Rabi cropping season is subjected to a rise and fall from Zone-I to Zone-VI (Fig. 6.3.3A). It increases to 0.96% in Zone-II, decreases to 0.77% in Zone-III, again decreases to 0.14% in Zone-IV, then increases to 0.61% in Zone-V. In Zone-VI cultivation of vegetables is not recorded. The scatter plot with least square line (Fig. 6.3.8B) shows a general declining trend of the distribution of Rabi vegetables with increasing distance from the railway. A moderate correlation of -0.524 and a regression coeffecient of -0.0519 also reveal the fact of an average declining trend. Moreover, the coefficient of determination of 0.2746 indicates that only 27.46% of the spatial variation in the distribution of Rabi vegetables is explained by distance from the railway. The t-statistic of 1.233 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It implies that the proportionate decrease in the distribution of Rabi vegetabels is not real and is due to chance.

Thus, the hypothesis that the area under vegetable crops decreases in response to decreasing accessibility or increasing distance from the railway is rejected. Since, market gardening depends largely upon assured water supply, fertility of soil and the factors of demand and ready market, therefore, it seems that accessibility from a line of communication like railway plays a secondary role in defining the locational patterns of vegetables. In zones along railway inspite of better irrigation facilities (Appendix-V), very small area is put under vegetables. This reflects upon the unsuitability of sample villages of these zones with respect to a market place.

(v) **Oil seeds (Kharif)** - The area under oilseeds of Kharif cropping season shows no specific trend . It decreases up to Zone-III, then it is subjected to a sequence of increase, decrease, and increase in the remaining zones (Fig. 6.3.4A). The scatter plot with least square line (Fig. 6.3.4B) depicts an average decreasing trend of the distribution of Kharif oil seeds. A weak negative correlation of -0.468 with a negative regression coefficient of -0.101 supports the above statement. Moreover, the coefficient of determination of 0.2190 indicates that only 21.90% of the spatial variation in the distribution of Kharif oil seeds is explained by distance from the railway. The t-statistic of 1.058 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It means that the proportionate distribution of Kharif oil seeds is not real and is due to chance.

Thus, the hypothesis that area under oil seeds of Kharif season increases with increasing distance from the railway is not acceptable. Since, Til the only oil seed grown in Kharif cropping season invites little attention by the farmers for being cultivated, therefore, it occupies very small area. Moreover, the selection of this crop for cultivation at a particular location is a more subjective decision of the farmers than the objective one based on market information. Hence, no specific trend of cultivation of oil seeds is cited in this part of the study area. This describes the grave weakness of the hypothesis related to the location of Kharif oil seeds in respect of the decreasing accessibility from railway in the study area. The hypothesis is rejected not because of insufficient favourable statistical support, but for the reasons, that statistical findings are estabilished against the related postulation.

(vi) **Oil seeds (Rabi)** - The graph for the area under Rabi oil seeds decreases continuously upto a distance of 8 kilometers (Zone-IV) then it increases sharply in Zone-V (41.71%), and again drops to a level of 5.22% (Fig. 6.3.4A). Therefore, it can be assessed that the curve sets no specific trend of distribution of Rabi oil seeds. The scatter plot with least square line (Fig. 6.3.9B) also provides an apparent average decreasing trend which is rather more confusing. The correlation coeffiecient of -0.291 with a negative regression coefficient of -1.236 also confirms the above statement. Moreover, the coefficient of determination of 0.0847 indicates that only 8.47% of the spatial variation in the distribution of Rabi oil seeds is explained by distance from the railway. The t-statistic of 0.609 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It implies that the proportionate decrease in the distribution of Rabi oil seeds is not real and is is due to chance.

The hypothesis that the area under oil seeds increases with increasing distance from the railway stands rejected. It means that accessibility has little impact and there are some other factors which are more important for the location of Rabi oil seeds. Since Rabi oil seed crops require little amount of water for cultivation, the irrigation facilities also do not have a bearing on the distribution of these crops. However, good yield, and attractive prices for mustard/rape seed explain that why these crops show a second ranking presence after cereals in the zones along Delhi-Jaipur railway wihtout exhibiting any declining or increasing trend having a proper statistical backing.

(vii) **Fodder (Kharif)** - The area under fodder of Kharif cropping season shows a continuous decline in its trend up to a distance of 6 kilometers (Zone-III), with a marginal rise in its value in Zone-IV. However, in Zone-V, the area under fodder is very high (16.56%). Zone-VI registeres a lowest value of 2.17% while Zone-V a highest figure of 16.56% of the area under fodder crops (Fig. 6.3.5A). The scatter plot with least squar line (Fig. 6.3.5B) shows an average trend which is not well defined. An extremely weak positive correlation of 0.068 with a positive regression coefficient of 0.0984 confirms the above statement of imperceptible distribution of Kharif fodder. Moreover, the coefficient of determination of 0.0046 indicates that only 0.46 % of the spatial variation in the distribution of Kharif fodder is explained by distance from the railway. The t-statistic of 0.136 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is highly insignificant at even more than 0.05 level of significance. It implies that the proportionate distribution of Kharif fodder is not real and is merely due to chance.

The hypothesis that the area under fodder will decrease with decreasing accessibility or in other words with increasing distance from the railway is therefore, not accepted for want of proper statistical support. Since, locationally significant cropping pattern of fodder would depend more upon other factors like substantial developemt of dairy industry, ready market for dairy products etc. The zone-wise distribution of Kharif fodder (Appendix-V) exhibits that after cereals fodder is, the second, most important crop in the zones along Delhi-Jaipur Railway. Excluding Zone-V it appears that fodder occupy prime location in the inner zones with an obvious successive decline. It reveals that fodder enjoys an important position in the economy of this area. Small amount of summer rains with little spatial variability is sufficient for raising fodder crops even at great distances from the railway. This explains why in Kharif fodder is preferred to be grown, at greater distances from the railway. The apparent gradual decline in the distribution of fodder from railway (except Zone-V) states that accessibility to a transportation artery at macro-level is of some significance for a low-value high-bulk crops of fodder.

(viii) **Fodder (Rabi)** - The area under fodder crops of Rabi cropping season shows a gradual decline right from Zone-I to Zone-V, (Fig. 6.3.5A) with a small increase in its value in Zone-III (1.15%). The scatter plot with least square line (Fig. 6.3.10B) shows a sharp declining trend of the distribution of fodder with decreasing accessibility from railway. A very strong negative correlation of -0.916 and a regression coefficient of -0.224 further strengthen the above mentioned statement. Moreover, the coefficient of determination of 0.8391 indicates that 83.91% of the spatial variation in the distribution of Rabi fodder is solely explained by distance from the railway. The t-statistic of 4.582 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.01 level of significance. It means that the proportionate decrease in the distribution of Rabi fodder is real and is not due to chance.

Hence, the hypothesis that the area under fodder crops decreases with increasing distance from the railway holds good and is, therefore, accepted. A poor representation of fodder in Zone-IV and a complete absence in Zones-V and VI (Appendix-V) is witness to the fact that accessibility to a transportation artery is of much significance for the location of crops like fodder which bear a low-value high-bulk character. More area devoted to fodder cultivation in inner zones states that commercial dairy farming is an important activity of rural population in this area.

(ix) Pulses (Rabi and Kharif)

Note : There is no cultivation of pulses in both cropping season except in only Zone-I and Zone-II of Kharif season with precentage of area under them as 0.31% and 0.41% (Fig. 6.3.6A). Hence, testing of hypothesis is not carried out in the case of distribution of pulses in zones along railway.

In case of oblonged zoning along Delhi- Jaipur Railway, the only hypothesis which was proved and accepted was only about the fodder crops of Rabi cropping season. All other remaining crops/ crop groups, however, could not justify their respective hypotheses. The hypotheses regarding pulses of both rabi and Kharif cropping seasons were not tested because of their little share in the study area.

PARALLEL ZONING ALONG DELHI-ALWAR STATE HIGHWAY NO. - 13 (NUH-NAGINA PART)

(a) Cropping intensity and distance from the highway

A close examination of the graph showing double cropped area

Locational Patterns of Cropping and Distance from Delhi - Jaipur Railway
(1993-94)

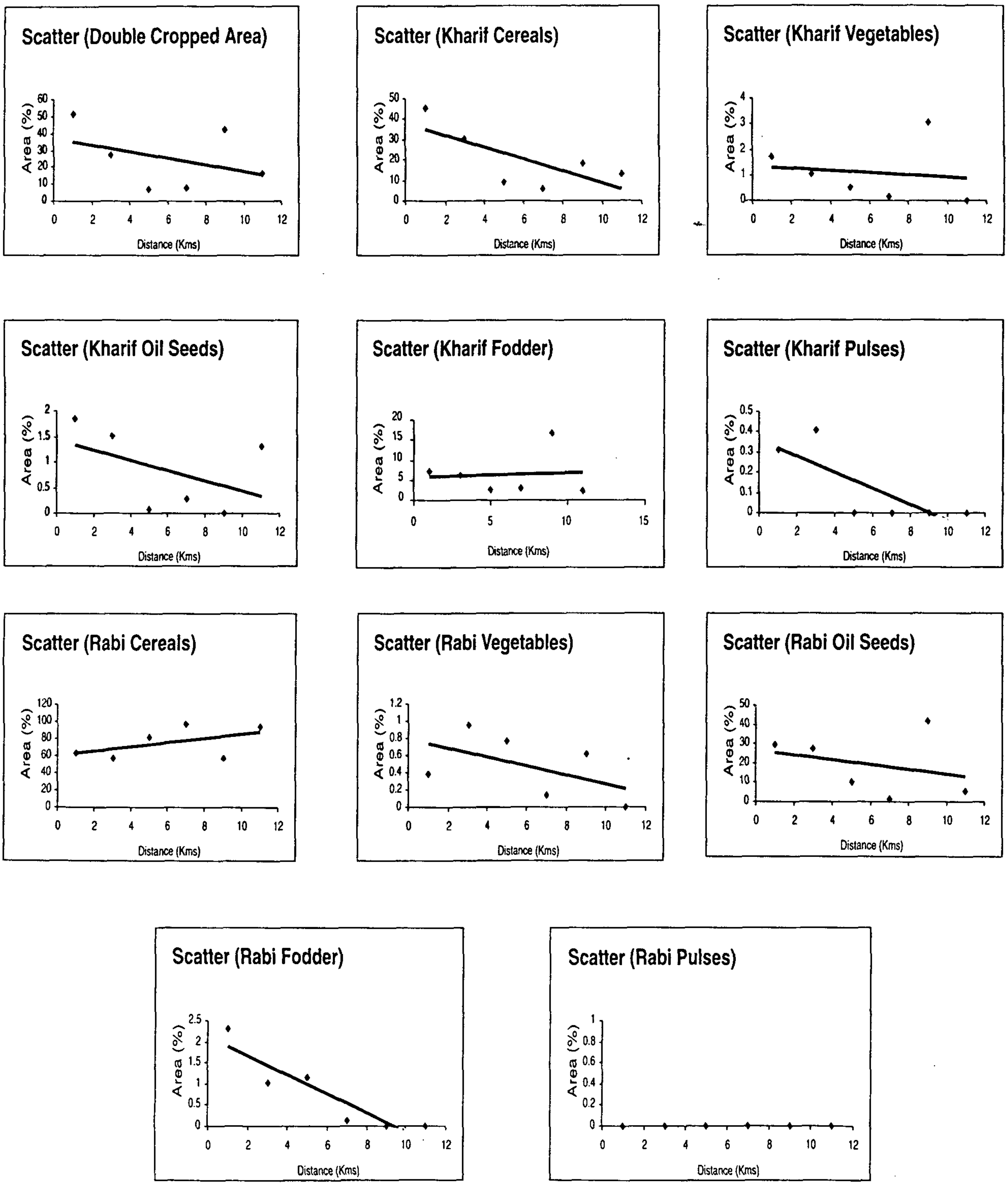
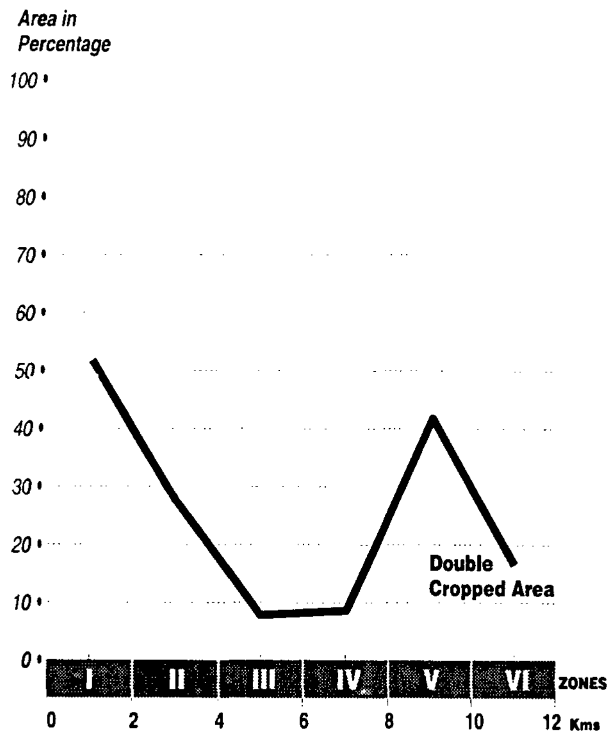


Fig. 6.3

INTENSITY OF CROPPING

Oblonged Zoning Along Delhi-Jaipur Railway
(1993-94)

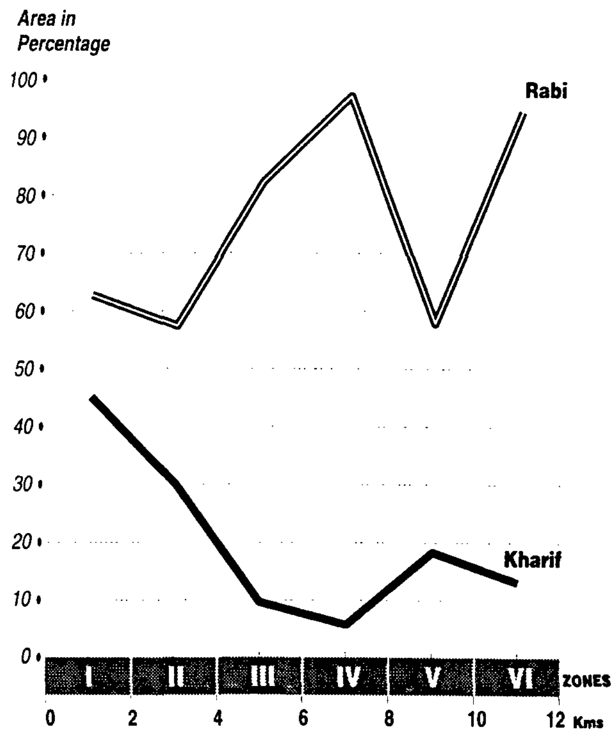
Fig-6.3.1A



CEREAL CROPS

Oblonged Zoning Along Delhi-Jaipur Railway
(1993-94)

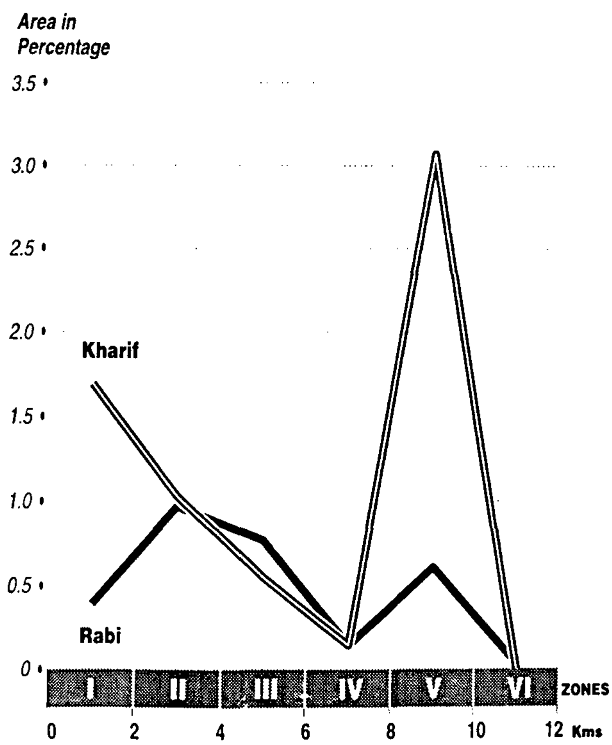
Fig-6.3.2A



VEGETABLES

Oblonged Zoning Along Delhi-Jaipur Railway
(1993-94)

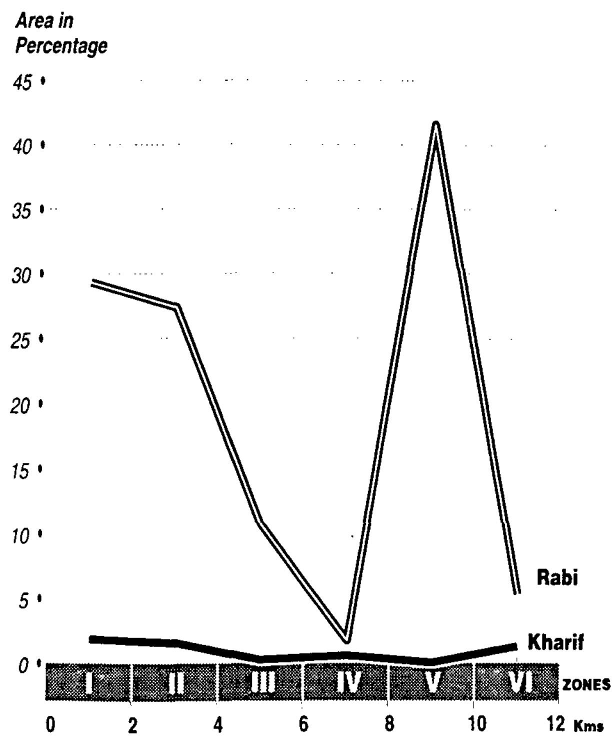
Fig-6.3.3A



OIL SEEDS

Oblonged Zoning Along Delhi-Jaipur Railway
(1993-94)

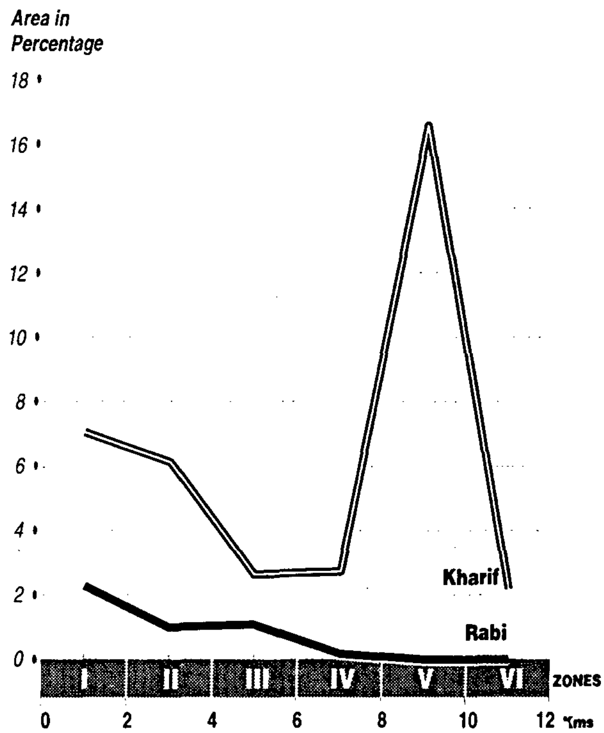
Fig-6.3.4A



FODDER

Oblonged Zoning Along Delhi-Jaipur Railway
(1993-94)

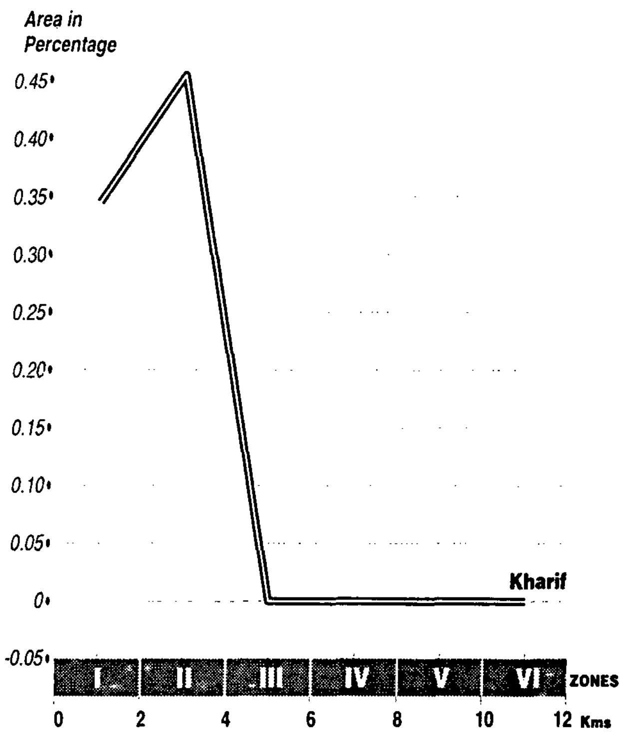
Fig-6.3.5A



PULSES

Oblonged Zoning Along Delhi-Jaipur Railway
(1993-94)

Fig-6.3.6A



(Fig. 6.4.1A) reveals that upto a distance of 6 kilometers (Zone-III) it is decreasing, and then up to a distance of 10 kilometers (Zone-V), it increases to a peak value of 74.70%. In Zone-VI, there is a slight decline in the area under double cropping (72.94%). The scatter plot with least square line (Fig. 6.4.1B) shows an average increasing trend of cropping intensity with increasing distance from the highway. A moderately high correlation of 0.664 and a regression coefficient of 4.209 points towards an average increase amidst the high scatter of points.

The coefficient of determination of 0.4409 indicates that only 44.09% of the spatial variation in the cropping intensity is explained by the factor of distance from the highway. The t-statistic of 1.777 with 4 degrees of freedom shows that the regression coefficeient is not significant even at more than 0.05 level of significance. It means that the proportionate increase in the cropping intensity is not real and is due to chance.

Hence, the hypothesis that intensity of cropping decreases with increasing distance from the highway/road is, therefore, not accepted. In fact other factors like assured water supply through irrigation, good rain fall, and fertility of soils are more important than accessibility to a road as far as distribution of cropping intensity is concerned. In fact greater proportion of irrigated area in the outer zones is more answerable for greater percentage of cropping intensiy away from the road. This explains why the proposition of decreasing cropping intensity with decreasing road accessibiliy is not accepted.

(b) Area under various categories of crops/crop groups (Kharif and Rabi) and the distance from highway

(i) **Cereals (Kharif)** - Among the cereals of Kharif cropping season of 1993-94, only three crops were significant. These crops were Jowar, Bajra and paddy which occupied 61.31% 24.34%, and 14.35% of the total area under the cultivation of Kharif cereals. Paddy is grown exclusively as a Kharif crop, the area of which is maximum in Zone-V and Zone-VI.

The area under cereal crops of Kharif cropping season (Fig. 6.4.2A) is showing a decline up to Zone-III and then it rises up to Zone-V and ends up with a slight decrease in Zone-VI. The decreasing area in Zone-II and Zone-III is perhaps due to the fact that in these two zones, the total area under Kharif crops is extremely low, which is 28.59% of the net area sown in zone-II and only 17.39% in Zone-III. The scatter plot with least square line (Fig. 6.4.2B) represents a rising trend of the distribution of Kharif cereals with increasing distance from the state highway. This statement is supported by a high positive correlation of 0.804 and a high value (4.767) of regression coefficeient. Moreover, the coefficient of determination of 0.6464 indicates that 64.64% of the spatial variation in the distribution of Kharif cereals is alone explained by distance from the state highway. The t-statistic of 2.7078 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It means that the proportionate increase in the distribution of kharif cereals is real and not due to chance.

Hence, the hypothesis that area under cereal crops increases with increasing distance from the highway is, therefore, accepted. Since, the intensity of cultivation of cereals depends upon the additional doses of inputs like labour, fertilizers etc. The application of extra doses of these input is affected by increasing distance from the road or in other words by decreasing accessibility, moreover, Kharif cereals require less amount of water, therefore, extensification of cultivation is observed in other zones away from the road.

(ii) **Cereals (Rabi)** - During the Rabi cropping season of 1993-94 in the sampled villages, only three cereal crops were cultivated. Wheat occupied 70.21%, gram occupied 24.42%, and barley occupied 5.37% of the total area under cultivation of Rabi cereals.

The area under cereals of Rabi cropping season is showing an increase in Zone-II (47.28%), a decrease in Zone-III (24.54%), an increase in Zone-IV (50.35%), an increase in Zone-V (93.57%), and a decrease in Zone-VI (Fig. 6.4.2A). The curve therefore, has no specific trend. The scatter plot with least square line (Fig. 6.4.7B) represents an average increasing trend which is much imperceptible. A positive correlation of 0.528 and a regression coefficient of 3.234 supports the above statement about the distribution of Rabi cereals. However, the coefficient of determination of 0.2788 indicates that only 27.88 % of the spatial variation in the distribution of Rabi cereals is explained by distance from the State Highway No. 13. The t- statistic of 1.242 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It means that the proportionate increase in the distribution of Rabi ceraels is not real and is due to chance.

Hence, the hypothesis that area under cereal crops increases with increasing distance form the highway is not accepted. It suggests that accessibility from a road plays an important role in determining the intensity of cropping which in itself depends upon the doses of inputs applied to the fields in Rabi season. So, the application of inputs to the fields is affected by accessibility from the road. In Rabi cereals wheat is the main crop, the high yielding varieties of which require much irrigation of the fields. The area under irrigation is comparatively more in the outer zones away from the road. Therefore, it is an example of intensive and commercial farming of cereals (Appendix-VI). This explains, that how, locational increase in acreage of in Rabi cereals is observed, which, however, statistically is not supported well.

(iii) **Vegetables (Kharif)** - The area under vegetables of Kharif cropping season is characterised with a decline upto Zone-III, thereafter, it increases up to Zone-V and decreases again in Zone-VI (Fig. 6.4.3A). The declining trend upto Zone-III is perhaps due to very small area is put to the cultivation in Zone-II and Zone-III during Kharif cropping season on one hand and reletively small area put to irrigation specially in Zone-II (3.56%). The scatter plot with least square line (Fig. 6.4.3B) shows an average increasing trend with distance from the road. A moderate correlation of 0.529 with regression coefficient of 0.124 provides a weak support to the rising trend. Moreover, the coefficient of determination of 0.2798 indicates that only 27.98 % of the spatial variation in the distribution of Kharif vegetables is explained by distance from the road. The t-statistic of 1.248 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is not significant even at more than 0.05 level of significance. It suggests that the proportionate increase in the distribution of Kharif vegetables is not real and is due to chance.

Hence, the hypothesis that area under vegetables decreases with increasing distance from the road during Kharif season is therefore, not accepted. It can therefore, be argued that road accessibilty has least bearing on the location of Kharif vegetables. However, other factors like location of tube-wells and summer monsoon rains are the definite determainants of the location of Kharif vegetables. Higher irrigation intensity and more concentration of vegetables in last three zones explains that accessibility to a road is not a sole determinant of the location of vegetables at macro-level.

(iv) **Vegetables (Rabi)** - The area under vegetables of Rabi cropping season is subjected to a constant decline up to Zone-V and exhibits a slight increase in Zone-VI (Fig. 6.4.3A). Mainly because in Zone-IV the area put to irrigation is at its highest value of 35.63%. The area put to the cultivation of vegetables is also comparatively very high (1.02%). The scatter plot with the least square line (Fig. 6.4.8B) exhibits a sharp decline in the distribution of vegetables as the distance from the road increases. A strong negative correlation of - 0.879 with a negative regression of - 0.229 exhibits a strong but negative relationship between the road accessibility and the distribution of Rabi vegetables. Moreover, the coefficient of determination of 0.7726 indicates that 77.26 % of the spatial variation in the distribution of Rabi vegetables is alone explained by road accessibilty. The t-statistic of 3.692 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.01 level of significance. It implies that proportionate distribution of Rabi vegetables is real and is not due to chance.

Hence, the hypothesis, that area under vegetables decreases with increasing distance from the highway therefore, stands valid. The apparent distribution of Rabi vegetables states that in Zones-IV and V the total absence of vegetables is defying the influence of irrigation facilities available in the same zones. This fact further explains that here comes the power of dicision making of the farmers which defines the locational patterns of crops. In these two zones the net sown area figures as read from Appendix-VI are 282 and 249 hectares which are the smallest figures, compared to other zones of production. Wheat which forms staple diet of the people of study area is invariably a first choice of the farmers for subsistence as well as commercial purposes. This explains why Rabi vegetables are not produced in Zones-IV and V inspite of better irrigation facilities. More area devoted to vegetables nearby the road in inner zones explains that road accessibility is an important factor for fetching vegetables quickly to the nearby markets, though, it is not a sole factor governing the location of vegetables.

(v) **Oil seeds (Kharif)** - Form Zone-I to Zone-VI, the area under oil seeds of Kharif cropping season is subjected to decrease, decrease, increase, decrease and increase (Fig. 6.4.4A). No specific trend is exhibited. The scatter plot with least square line (Fig. 6.4.4B) exhibits an increasing trend which is not well defined. A weak positive correlation of 0.318 and a positive regression coefficient of 0.116 does not confirm the above statement. Moreover, the coefficient of determination of 0.1011 indicates that only 10.11 % of the spatial variation in the distribution of Kharif oil seeds is explained by distance from the state highway. The t-statistic of 0.672 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is not significant even at more than 0.05 level of significance. It suggests that the proportionate increase in the distribution of Kharif oil seeds is not real and is due to chance.

The hypothesis that the area under oil seeds (Kharif) will increase with increasing distance from the road is, therefore, not accepted. It refers to that the accessibility from a road has little impact on the distribution of Kharif oil seeds.

(vi) **Oil seeds (Rabi)** - The area under oil seeds of Rabi cropping season as well is not presenting any well defined trend, since form Zone-I onward, the graph is showing a rise in Zone-III, and Zone-VI, while in other zones it is showing a decline (Fig. 6.4.4A). The scatter plot with least square line (Fig. 6.4.9B) represents a decline in the distribution of Rabi oil seeds. An average negative correlation of -0.653 and a regression coefficient of -4.289 suggests that the declining trends of the distribution of Rabi oil seeds is not much significant. A coefficient of determination of 0.4264 indicates that only 42.64% of the spatial variation in the distribution of Rabi oil seeds is explained by distance from the state highway. The t-statistic of 1.724 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is not significant even at more than 0.05 level of significance. It suggests that the proportionate distribution Rabi oil seeds is not real and is due to chance.

The hypothesis that the area under oil seeds of Rabi season will increases with increasing distance from the road is not acceptable. Since, in arid and semi-arid climates where the choice of the farmers to grow crops is also restricted, oil seeds become an attraction to the farmers, because they are also high remunerative crops. The more area put under oil seeds in the inner zones is therefore, a part of intensification of oil seeds rather than extensification. This explains, why the apparent distribution of oil seeds is biased against the formulated proposition.

(vii) Fodder (Kharif) - The percentage of area under fodder crops of Kharif season (Fig. 6.4.5A) is subjected to a decline upto Zone-III, then it increases in Zone-IV, decreases is Zone-V, and again increases in Zone-VI. A relatively much lower values for Zone-II and Zone-III are perhaps attributed to very low area put to cultilvation during Kharif in these two zones on one hand and relatively low intensity of irrigation in these zones. The scatter plot with least square line (Fig. 6.4.5B) exhibits an average decline in the distribution of Kharif fodder. This trend is rather much confusing. A correlation of -0.496 along with a regression coefficient of -0.727 reiterates that there exists a fuzzy relationship between the distribution of Kharif fodder and road accessibility. Moreover, the coefficient of determination of 0.2460 indicates that only 24.60 % of the spatial variation in the distribution of Kharif fodder is explained by distance from the road. The t-statistic of 1.144 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It implies that the proportionate decrease in the distribution of Kharif fodder is not real and is due to chance.

Hence, the hypothesis that area under fodder crops decreases with increasing distance from the highway is not acceptable. Therefore, it can be argued that road accessibility has no significant bearing on the distribution of Kharif fodder. Apparently more concentration of fodder in the inner zones and a substantial representation in other zones state that commercial dairy farming is practiced.

(viii) **Fodder (Rabi)** - The graph showing area under fodder crops of Rabi cropping season is having a declining trend upto Zone-IV. Zone-IV onward it registers an increase up to Zone-VI (Fig. 6.4.5A). This increase in Zone-V and Zone-VI is mainly due to high intensity of cropping 74.70% and 72.94% coupled with less area devoted to other crops in these zones. The scatter plot with least square line (Fig. 6.4.10B) represents a declining trend with distance from the state highway. A strong negative correlation of -0.799 along with a negative regression coefficient of -0.443

describes that there exists a strong relationship between the distribution of fodder and road accessibility.

The coefficient of determination of 0.6384 indicates that only 63.84% of the spatial variation in the distribution of Rabi fodder is explained alone by distance from the road. The t-statistic of 2.656 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It implies that the proportionate distribution of Rabi fodder is real and is not due to chance.

Hence, the hypothesis that area under fodder crops decreases with increasing distance from the road is accepted in the case of Rabi cropping season. It implies that road accessibility and the nature of the fodder crops - being low value and bulky, generate less economic rent after a certain distance, and the dairy industry developed nearer the consuming centre would be generating the greater economic rent for fodder if produced at smaller distances.

(ix) **Pulses (Kharif)** - The area under pulses of Kharif cropping season (Fig.6.4.6A) is showing a constant decline up to Zone-III. It increases in Zone-IV and Zone-V, and then decreases again in Zone-VI. This decline in the area of Kharif pulses in Zone-II and Zone-III seems to be a consequence of extremely low area put to the cultlivation in these two zones during Kharif season. The scatter plot with least square line (Fig. 6.4.6B) shows an increase in the area under Kharif pulses with an increasing distance from the road. A high positive correlation of 0.788 and a low positive regression coefficient (0.057) confirms the validity of the above mentioned statement. Moreover, the coefficient of determination of 0.6209 indicates that 62.09 % of the spatial variation in the distribution of Kharif pulses is alone explained by distance from the road. The t-statistic of 2.561 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at more than 0.05 level of significance. It implies that the proportionate increase in the distribution of Kharif pulses is real and not due to chance.

Hence, the hypothesis that area under pulses of Kharif cropping season will increase with increasing distance from the road is, therefore, accepted. The statistically guarded confirmation of this hypothesis came true only in this case of Kharif pulses. It indicates that during Kharif season, summer rains and farmers' preferences for cropping patterns along with accessibility from the road leads to economic realisations for the locational pattern of pulses.

(x) **Pulses (Rabi)** - The graph of the distribution of area under pulses of Rabi cropping season (Fig. 6.4.6A) is showing a continuous declining trend from Zone-I to Zone-V. Only from Zone-V to Zone-VI, it registers an increase. The scatter plot with least square line (Fig. 6.4.11B) also shows an average declining trend which is rather confusing. An average negative correlation of -0.415 along with a negative regression coefficient of -0.063 seems not very much effective in defining the declining trend of the distribution of Rabi pulses. Moreover, the coefficient of determination of 0.1722 indicates that only 17.22 % of the spatial variation in the distribution of Rabi pulses is explained by distance from the road. The t-statistic of 0.911 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It implies that the distributional trend of Rabi pulses under the impact of distance from road is not real and is due to chance.

Hence, the hypothesis that the area under pulses of Rabi season will increase with increasing distance from the highway/road is rejected.

In case of parallel zoning along Delhi-Alwar State Highway No. 13, the hypotheses which were proved true stastistically and were accepted, were about Kharif cereals, Kharif pulses, Rabi vegetables and Rabi fodder. All other remaining crops/crop groups, however, could not justify their respective hypotheses.

PARALLEL ZONING ALONG PATAKPUR MINOR DISTRIBUTARY OF GURGAON CANAL

(a) Cropping intensity and distance from the canal

An examination of the curve showing double cropped area along the Patakpur Minor Canal seems to establish a relationship between the intensity of cropping and increasing distance from the canal

Locational Patterns of Cropping and Distance from Delhi - Alwar Highway

(1993-94)

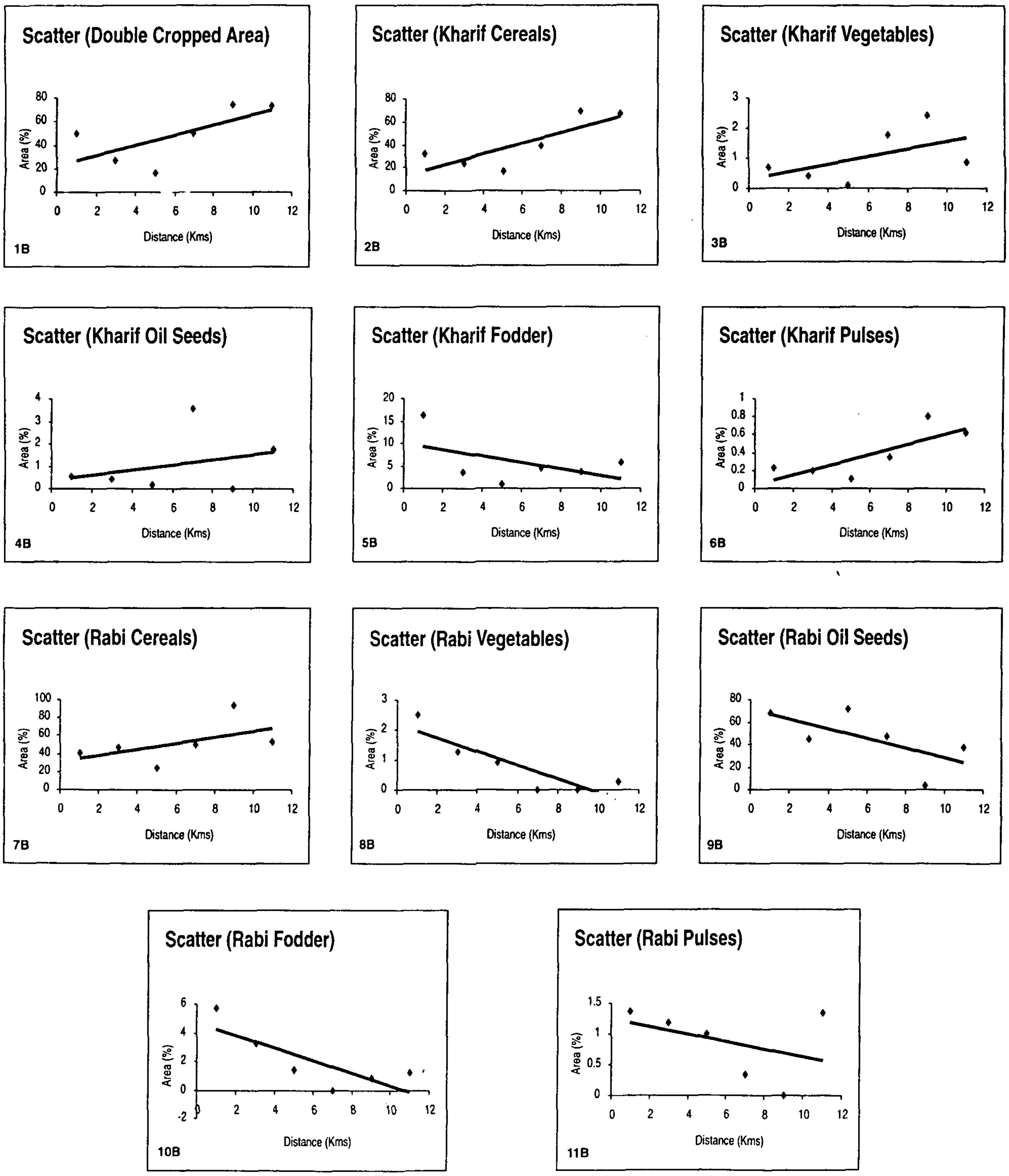
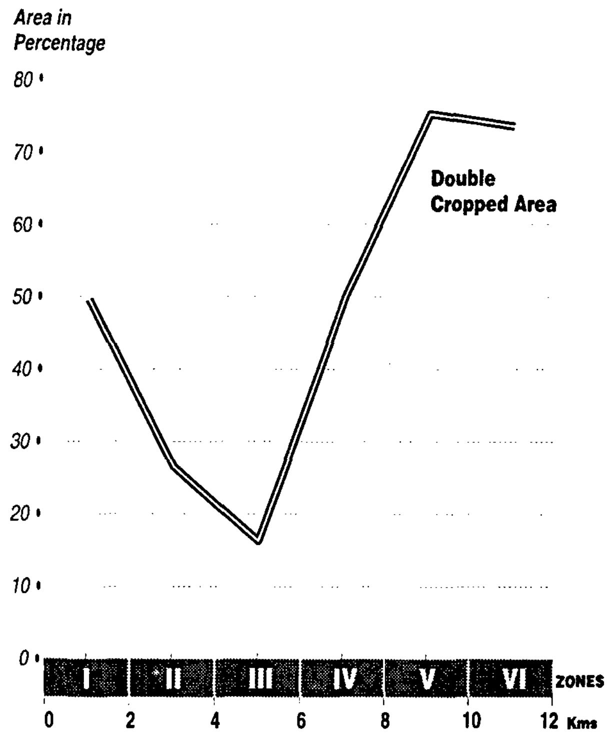


Fig. 6.4

INTENSITY OF CROPPING AND IRRIGATION

Parallel Zoning Along Delhi-Alwar Highway (Nuh-Nagina Part)
(1993-94)

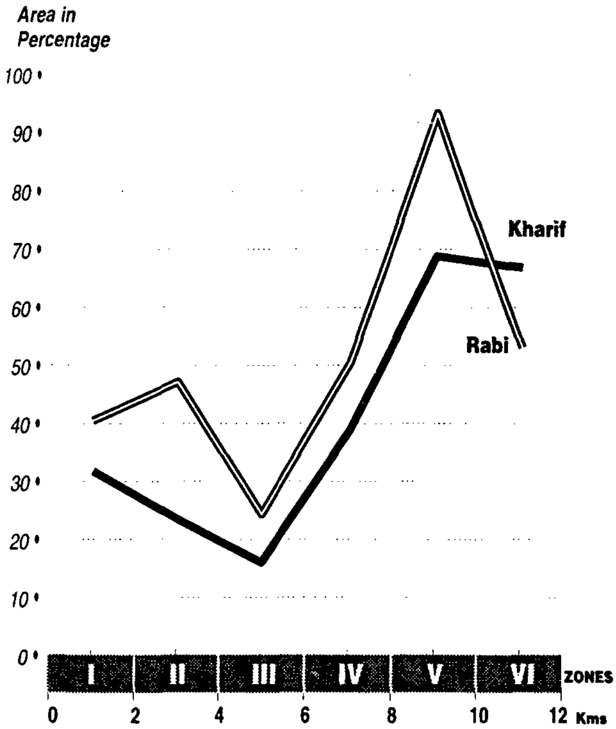
Fig-6.4.1A



CEREAL CROPS

Parallel Zoning Along Delhi-Alwar Highway (Nuh-Nagina Part)
(1993-94)

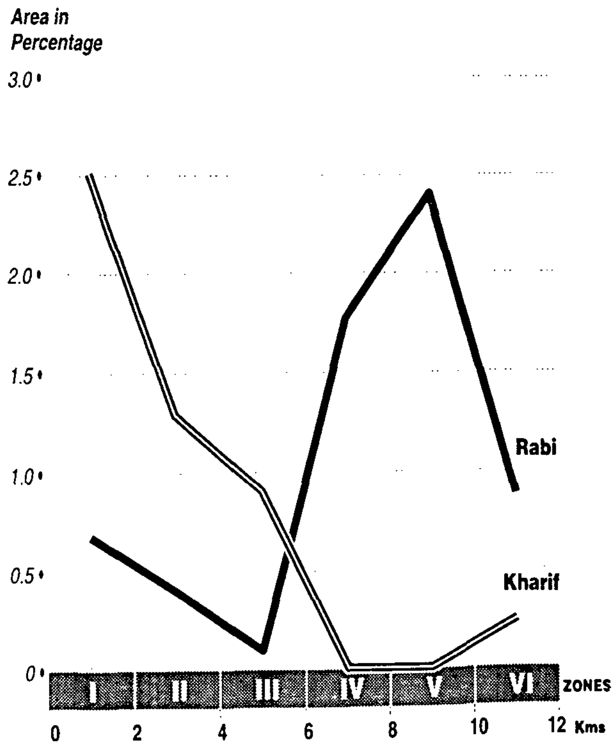
Fig-6.4.2A



VEGETABLES

Parallel Zoning Along Delhi-Alwar Highway (Nuh-Nagina Part)
(1993-94)

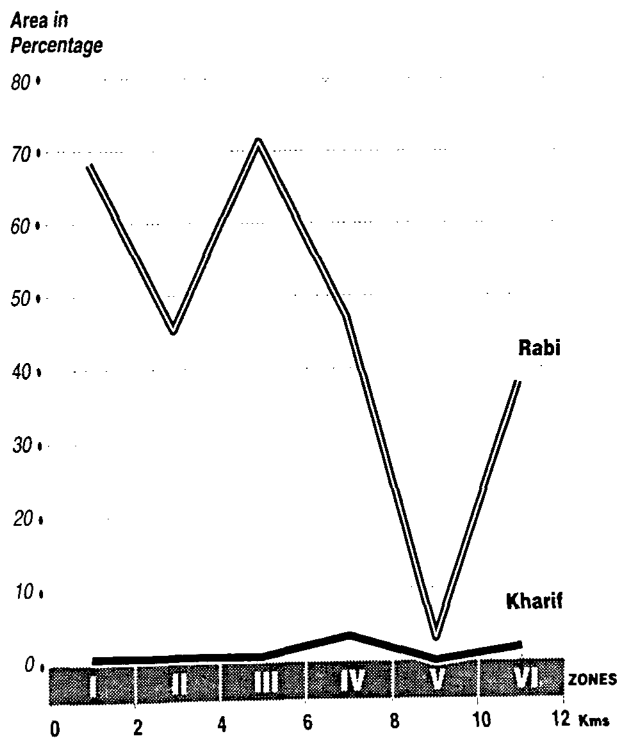
Fig-6.4.3A



OIL SEEDS

Parallel Zoning Along Delhi-Alwar Highway (Nuh-Nagina Part)
(1993-94)

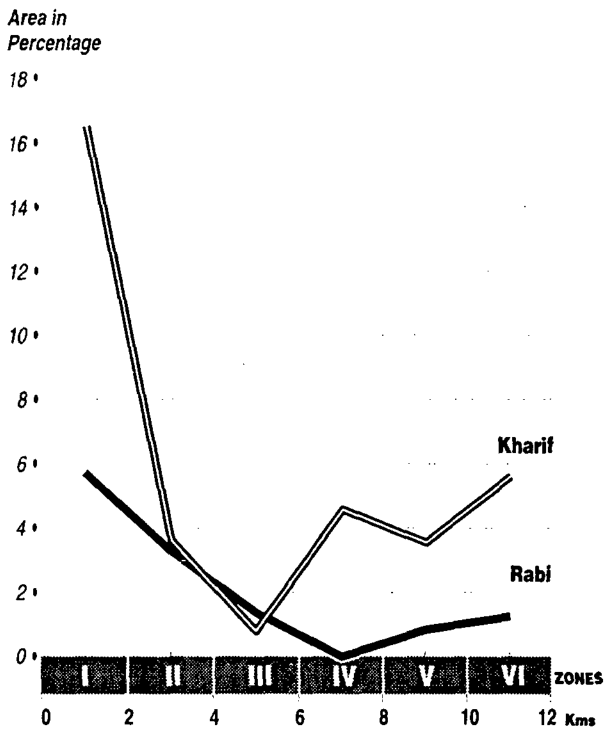
Fig-6.4.4A



FODDER

Parallel Zoning Along Delhi-Alwar Highway (Nuh-Nagina Part) (1993-94)

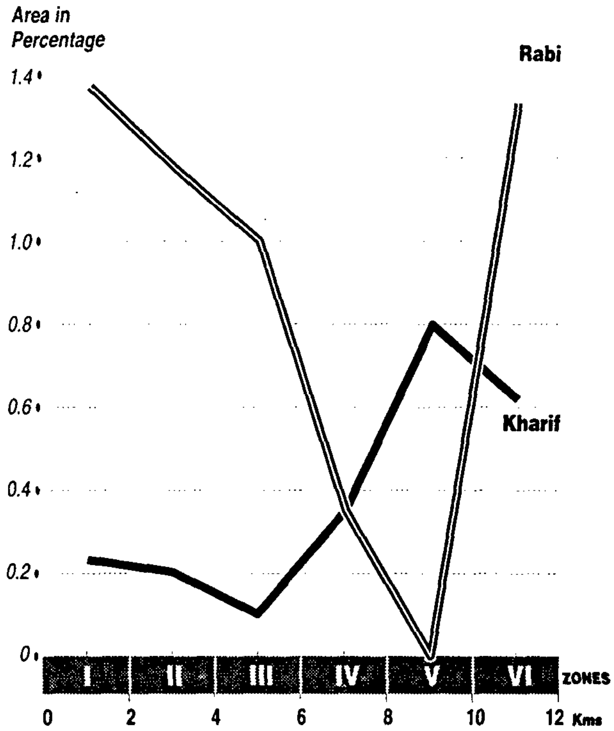
Fig-6.4.5A



PULSES

Zones Along Delhi-Alwar Highway (Nuh-Nagina Part) (1993-94)

Fig-6.4.6A



(Fig. 6.5.1A). It decrases in Zone-II, then increases in Zone-III and Zone-IV. In Zone-V it declines sharply to 33.89% and then increases to 52.11% in Zone-VI. The decline in Zone-V is perhaps due to very low *intensity of irrigation (28.81%) in the same zone.* The scatter plot with least square line (Fig. 6.5.1B) represents an average tendency of decline with distance. However, this trend is not perceptible and is rather fuzzy in behaviour. A negative correlation of -0.365 and regression coefficient -1.223 also exhibits a weak relationship between the declining trend of cropping intensity and increasing distance from the canal.

Moreover, the coefficient of determination of 0.1332 indicates that only 13.22% of the spatial variation in the cropping intensity is explained by the distance from the canal. The t-statistic of 0.783 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It means that the proportionate decrease in the cropping intensity is not real and is due to chance.

Hence, the hypothesis that intensity of cropping decreases with increasing distance from the canal does not holds true. The vaild argument for this finding may be that Gurgaon canal is not a perennial canal and is subjected to a dry spell during a long period every year. It swells over with water during the south-west monsoon season and remains with dry bed with intermittent water pools for the rest of the year. However, the level of sub-soil water remains shallow even during the dry period. This is why, that out of all the six zones only in two zones (Zone-III and Zone-VI) irrigation is paracticed directly from the canal. In Zone-II, out of 57.01% of the net irrigated area 36.83% is directly irrigated by canals and the remaining by tube-wells. In Zone-IV out of the 82.27% of the net irrigated area, 41.67% is directly irrigated by canal while the remaining is irrigated by tube-wells. Rest of the other zones (Zone-I, II, IV and V) are totally dependent upon tube-wells for irrigation. These tube-wells lift sub-soil water which is indirectly the canal water from a depth as shallow as under 10 meters (Fig. 1.5). The shallow water table is on account of the vicinity of Gurgaon canal. Thus, higher percentage of irrigation facilities in all the six zones specially in Zone-IV and VI, but except in Zone-V (28.81%) is perhaps the only valid reason for the rejection of this hypothesis.

(b) Area under various crop groups and distance from the canal

(i) Cereals (Kharif) - During the Kharif cropping season of 1993-94, in the sampled villages picked out of the parallel zones made along the Gurgaon canal only three cereal crops were grown. Bajra occupied 49.85%, Jowar 42.23% and paddy 7.84% of the net area put to the cultivation of cereals in Kharif season. The area under cereals of Kharif cropping season shows a negligible decline in Zone-II (31.40%), and then, it increases continuously upto Zone- IV. After Zone-IV it registers an increase in Zone-VI. It seems that distribution of cereals fails to establish any relationship with the increasing distance from the canal. (Fig. 6.5.2A). The scatter plot with least square line (Fig. 6.5.2B) apparently exhibits no mutual relationship between the distribution of Kharif cereals and increasing distance from the Patakpur distributary. An extremely weak correlation of -0.053 with a regression coeffecient of -0.217 also suppotr the above statement.

Moreover, the coefficient of determination of 0.0028 indicates that only 0.28% of the spatial variation in the distribution of Kharif cereals is explained by the distance from the canal. The t-statistic of 0.106 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It means that the proportionate decrease in the distribution of Kharif cereals is not real and is due to chance.

The hypothesis that area under Kharif cereal crops will increase with increasing distance from the canal is not acceptable. Since Kharif cereals do not depend much upon irrigation and are the crops of dry farming system, hence, their distribution is not showing any specific trend.

(ii) **Cereals (Rabi) -** During the Rabi cropping season of 1993-94 in the sampled villages along the Patakpur Minor distributary of Gurgaon Canal only three cereal crops were grown. Wheat occupied 95.34%, gram 3.58% and barley 1.08% of the total area put to the cultivation of the Rabi cereals.

The percentage of area under cereal crops of Rabi season (Fig. 6.5.2A) shows a trend which declines in Zone-II, then increases upto Zone-IV, and then gradually declines in Zone-V and Zone-VI. No specific relationship is observed. The scatter plot with least square line (Fig. 6.5.7B) represents an average increasing trend with fuzzy perception. A weak correlation of 0.463 with regression coefficient of 1.336 do not support the above mentioned statement.

Moreover, the coefficient of determination of 0.2143 indicates that only 21.43% of the spatial variation in the distribution of Rabi cereals is explained by the distance from the canal. The t-statistic of 1.045 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is not significant even at more than 0.05 level of significance. It means that the proportionate increase in the distribution of Rabi cereals is not real and is due to chance.

The hypothesis that area under Rabi cereal crops would decrease with increasing distance from the canal is, therefore, not acceptable for want of statistical support. As a matter of fact assured water supply for Rabi cereals in all zones of production justifies and explains that there exists commercial grain farming. Wheat the dominant Rabi crop seeks assured water supply. However, a weak increasing trend in the distribution of Rabi cereals is recorded.

(iii) Vegetables (Kharif) - The distribution of vegetables with increasing distance from the canal exhibits a negative relationship. It decreases with increasing distance form the canal (Fig. 6.5.3A) from Zone-I to Zone-VI. The scatter plot with line of best fit (Fig. 6.5.3B) climbs down sharply with increasing distance from the Gurgaon Canal. A very strong negative correlation of -0.904 and a negative regression coefficient of -1.178 state that there exists an strong but negative relationship between the disribution of Kharif vegetables and distance from the canal.

Moreover, the coefficient of determination of 0.8172 indicates that 81.72% of the spatial variation in the distribution of Kharif vegetables is explained alone by the distance from the canal. The t-statistic of 4.228 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.01 level of significance. It means that the proportionate decrease of Kharif vegetables is real and is not due to chance.

Hence, the hypothesis that area under vegetebles would decrease with increasing distance from the canal is, threfore, accepted. Under almost uniform rain fall/irrigation facilities the influence of the demand and ready market along with soil fertility which often decreases away from the settlements are significant factors for the location of vegetables, moreover, frequent visits to the vegetable fields by the farmers for the purpose of protection of vegetables from the stray animals, make it convenient for them to grow vegetables close to their habitat.

(iv) **Vegetables (Rabi)** - The area under vegetables of Rabi cropping season show a successive decline from Zone-I to Zone-III (Fig. 6.5.3A). In Zone-IV it registers an increase (1.02%) and again it declines gradualy upto Zone-VI. In fact in Zone-III, the area under vegetables is exceptionally low (0.10%). It is perhaps on account of that in this zone maximum area 83.25% is devoted to the cultivation of Rabi cereals while another 7.87% is devoted for the cultivation of Rabi oil seeds. If this low figure of Zone-III is overlooked, a genlte declining slope of the disrtibution cruve of vegetables would represent an inverse relationship with increasing distance from the canal. The scatter plot with least square line (Fig. 6.5.8B) also exhibits a gradual declining trend of vegetables distribution with increasing distance from the canal. A strong negative correlation of -0.795 and a negative regression coefficient of -0.185 suggests that there is an inverse relationship among the distribution of Rabi vegetables and distance from the canal.

Moreover, the coefficient of determination of 0.6320 indicates that 63.20% of the spatial variation in the distribution of Rabi vegetables is explained alone by the distance from the canal or canal irrigation intensity. The t-statistic of 2.623 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It means that the proportionate decrease of Rabi vegetables is real and is not due to chance.

Hence, the hypothesis that area under Rabi vegetables would decrease with increasing distance from the canal is accepted. The reasons for this acceptance are the same which are mentioned above in the case of Kharif vegetables.

(v) **Oilseeds (Kharif)** - The distribution of Kharif oilseeds from Zone-I to Zone-VI establishes an alternate increasing and decreasing trend, and seems to bear and inverse relationship with increasing distance from the canal, however, it seems to lie in conformity with irrigation intensity in different zones (Fig. 6.5.4A). The scatter plot with least square line (Fig. 6.5.4B) represents a sharp declining trend in the distribution of Kharif oil seeds. A strong negative correlation of -0.812 along with a negative regression coefficient of -0.851 further supports the statement mentioned above.

Moreover, the coefficient of determination of 0.6593 shows that 65.93% of the spatial variation in the distribution of Kharif oilseeds is alone explained by the distance from the canal. The t-statistic of 2.781 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It means that the proportionate distribution of Kharif oilseeds is real and is not due to chance.

The hypothesis that the area under oilseeds would increase with increasing distance from the canal is, therefore, not acceptable. The reverse trend of the distribution of Kharif oil seeds exhibits that Til, the only Kharif oil seed, for reasons of good remunerative value is an important crop in the economy of this part of study area. This explains why Kharif oil seeds show more concentration in inner zones of production.

(vi) **Oilseeds (Rabi)** - The distribution of the oilseeds of Rabi cropping season (Fig. 6.5.4A) exhibits a sharp increase in Zone-II and conversely a sharp decrease in Zone-III, and Zone-IV. From Zone-IV it registers a substantial increase in Zone-V and Zone-VI. It, therefore, fails to maintain any relationship with the increasing distance from the canal. The scatter plot with least square line (Fig. 6.5.9B) exhibits a fuzzy appearence of the distribution of oilseeds. A weak correlation of -0.289 with a regression coefficient of -0.814 further supports the above mentioned statment.

Moreover, the coefficient of determination of 0.0835 indicates that only 8.35% of the spatial variation in the distribution of Rabi oilseeds is explained by the distance from the canal. The t-statistic of 0.603 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It means that the proportionate distibution of Rabi oilseeds is not real and is due to chance.

Hence, the hypothesis that area under oilseeds would increase with increasing distance from the canal is therefore, rejected. It is, therefore, inplicit that distance from the canal has little bearing on the distribution of Rabi oilseeds. Since oil seeds require small quantity of water for being grown, the provision of irrigation facilities have little impact on the locational patterns. Economic consideration are perhaps more powerful in defining locational distribution of these crops.

(vii) **Fodder (Kharif)** - The area under fodder of Kharif cropping season is subjected to a sequence of decrease, increase, decrease, increase, and increase from Zone-I to Zone-VI (Fig. 6.5.5A). It seems to establish no relationship with the distance from canal. The scatter plot with least square line (Fig. 6.5.5B) depicts a slight increasing trend which is rather much confusing. A weak correlation of 0.359 wih a regression coefficient of 0.538 describes he same state of affairs.

Moreover, the coefficient of determination of 0.1289 indicates that only 12.89% of the spatial variation in the distribution of Kharif fodder is explained by the distance from the canal. The t-statistic of 0.770 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It means that the proportionate increase of Kharif fodder is not real and is due to chance.

The hypothesis that area under Kharif fodder would increase with increasing distance from the canal for want of statistical support is not acceptable. The apparent rise in the distributional trend of Kharif fodder points towards the development of dairy industry.

(viii) Fodder (Rabi) - The area under fodder of Rabi cropping season shows a sequence of decrease, increase, increase, decrease, and increase from Zone-I to zone-VI (Fig. 6.5.5A). It seems to maintain no relationship with increasing distance from the canal. The scatter plot with the line of best fit (Fig. 6.5.10B) represents an average declining trend which is not very much clear in its behaviour. A weak negative correlation of -0.475 and a regrresion coefficient cf -0.041 support the above mentioned statement.

Moreover, the coefficient of determination of 0.2256 indicates that only 22.56% of the spatial variation in the distribution of Rabi fodder is explained by the distance from the canal . The t-statistic of 1.079 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It means that proportionate distribution of Rabi fodder is not real and is due to chance.

Hence, the hypothesis that area under Rabi fodder, would increase with increasing distance from the canal stands rejected. In Rabi cropping season in zones along the Patakpur Minor distributary, in sample villages the focus of the farmers was much toward the cultivation of cereals and oil seeds. In Zone-II and Zone-V fodder is not cultivated at all, while in other zones it occupies a less than 1.0% area. Under such circumstances as a matter of fact a definite trend of distribution is difficult to be observed.

(ix) **Pulses (Kharif)** - The curve showing the distribution of Kharif pulses (Fig. 6.5.6A) is subjected to alternate increase and decrease right from the Zone-I to zone-VI. It appars to have stablished a declining trend with increasing distance from the canal. The scatter plot with least square line (Fig. 6.5.6B) shows a declining trend of the distribution of Kharif pulses. A strong negative correlation of -0.819 and a negative regression coefficient of -0.166 are supporting the above mentioned statement.

Moreover, the coefficient of determination of 0.6708 indicates that only 67.08% of the spatial variation in the distribution of Kharif pulses is alone explained by the distance from the canal. The t-statistic of 2.849 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It means that the proportionate increase in the distribution of Kharif pulses is real and is not due to chance.

The hypothesis that area under pulses would increase with increasing distance from the canal, therefore, stands cancelled. The valid reasons for the rejection of this hypothesis may be, pulses being less preferred crops occupy very small area in each zone, hence, locational pattern of pulses is not reliable It tells about a low significance level of pulses in the aggrarian economy of the region along Patakpur Minor Distributary.

(x) **Pulses (Rabi)** - The distribution of pulses in Rabi cropping season away from the canal is subjected to an alternate decrease and increase form Zone-I to Zone-VI. It fails to maintain any relationship with increasing distance from the canal (Fig. 6.5.6A). The scatter plot with least square line (Fig. 6.5.11B) represents an avarage increasing trend of the distribution of Rabi pulses which is imperceptible and rather confusing. The correlation of 0.418 with regression coefficient of 0.0222 also confirms that there exists a weak positive relationship between the distribution of Rabi pulses and distance from the canal.

Moreover, the coefficient of determination of 0.1747 indicates that only 17.47% of the spatial variation in the distribution of Rabi pulses is alone explained by the distance from the canal. The t-statistic of 0.922 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It means that the proportionate distribution of Rabi pulses is not real and is due to chance.

The hypothesis that area under pulses would increase with increasing distance from the canal, therefore, does not hold good

Locational Patterns of Cropping and Distance from Paťakpur Minor Canal
(1993-94)

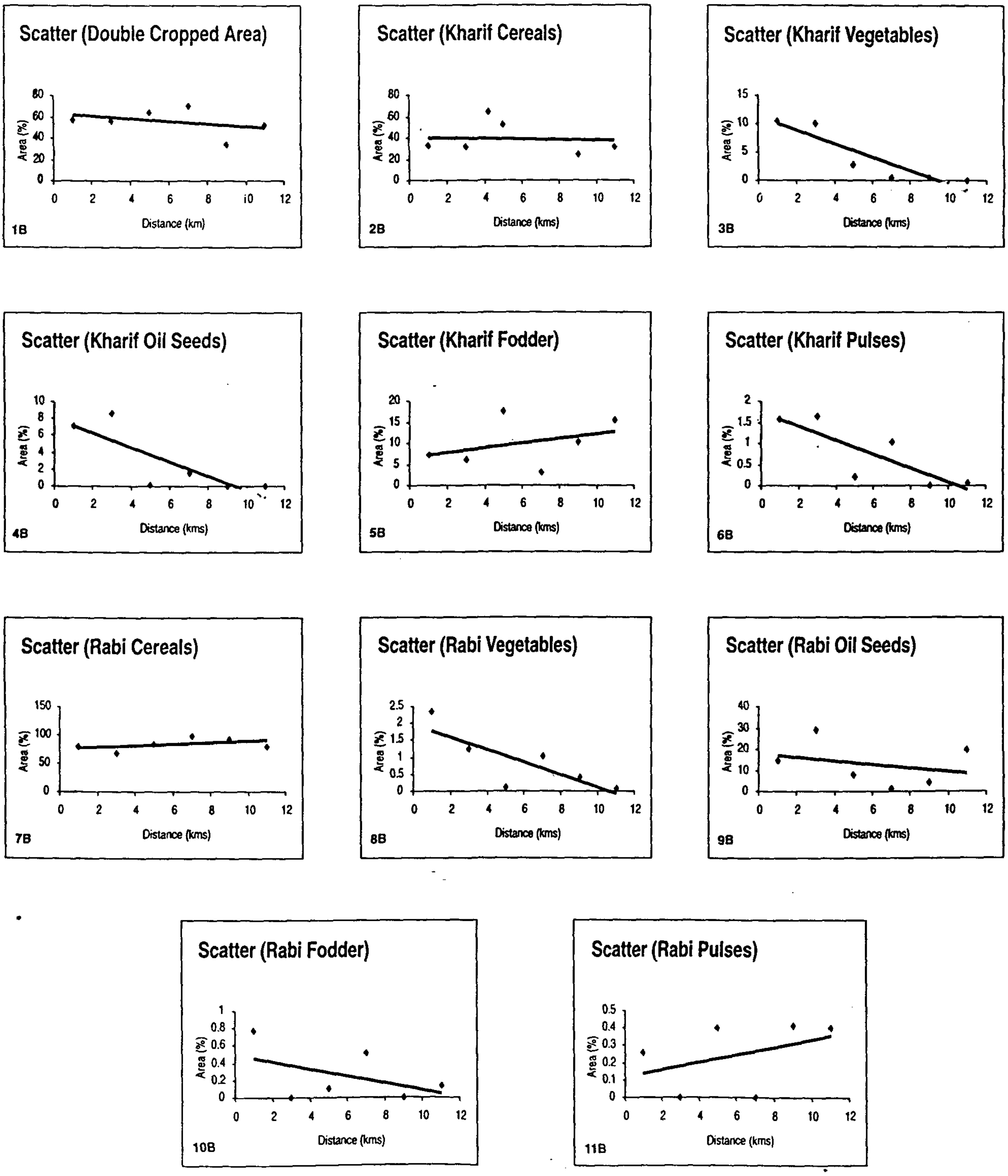
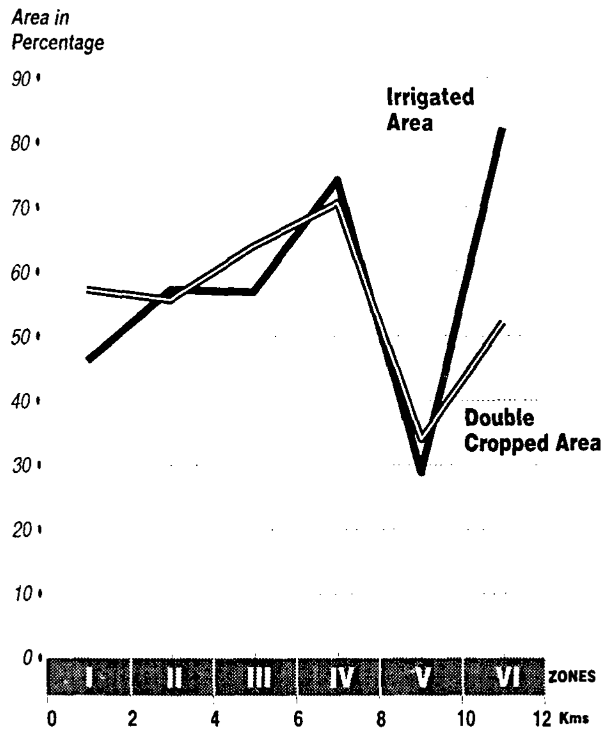


Fig. 6.5

INTENSITY OF CROPPING AND IRRIGATION

Parallel Zoning Along Patakpur Minor Canal (1993-94)

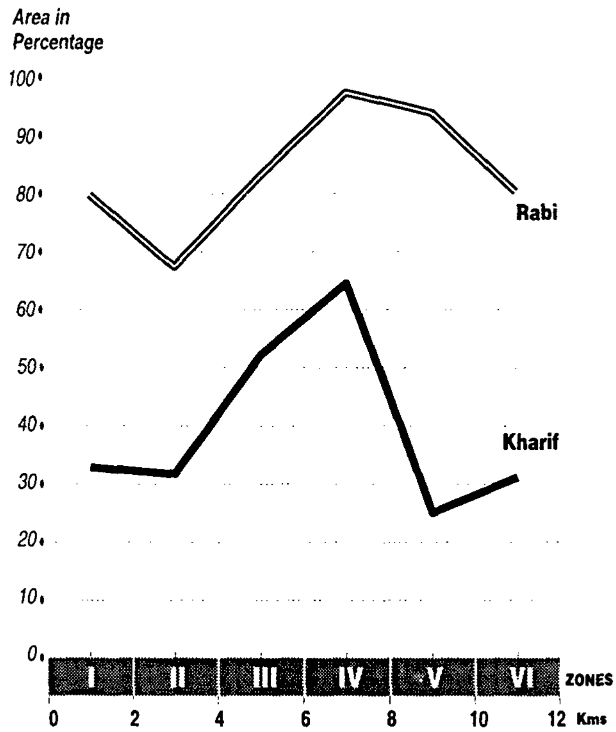
Fig-6.5.1A



CEREAL CROPS

Parallel Zoning Along Patakpur Minor Canal (1993-94)

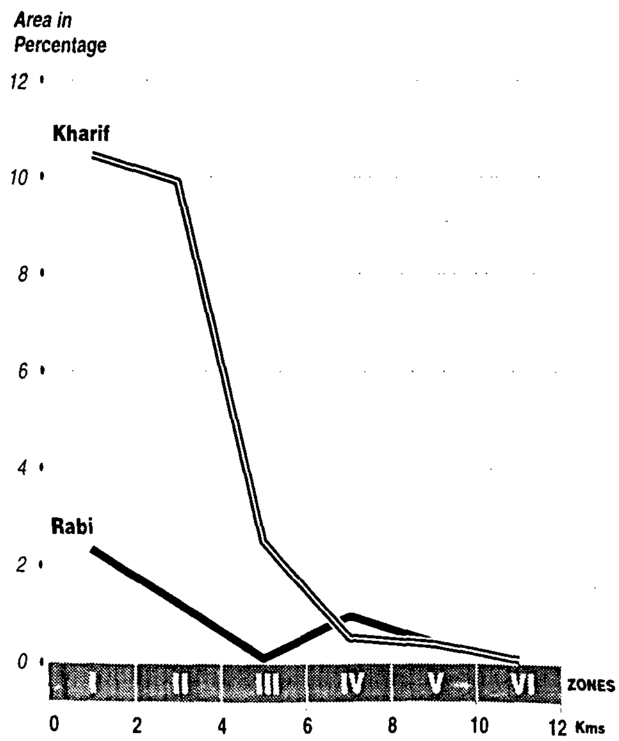
Fig-6.5.2A



VEGETABLES

Parallel Zoning Along Patakpur Minor Canal (1993-94)

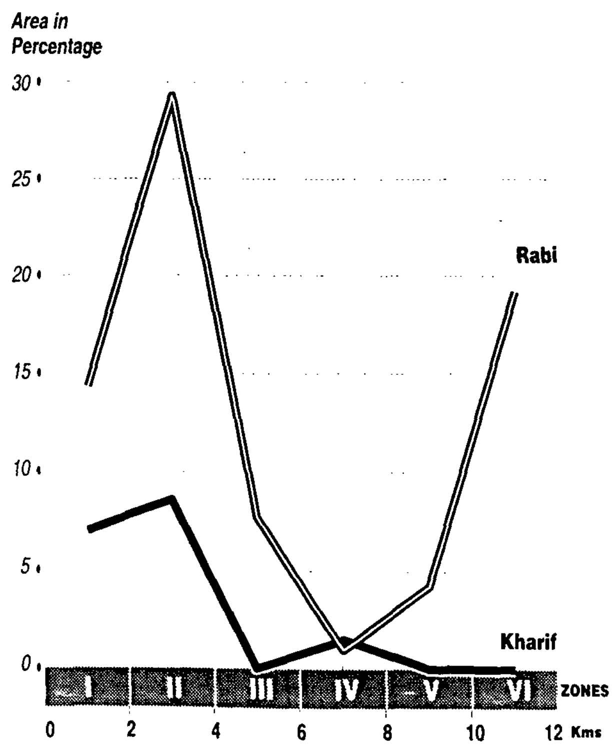
Fig-6.5.3A



OIL SEEDS

Parallel Zoning Along Patakpur Minor Canal (1993-94)

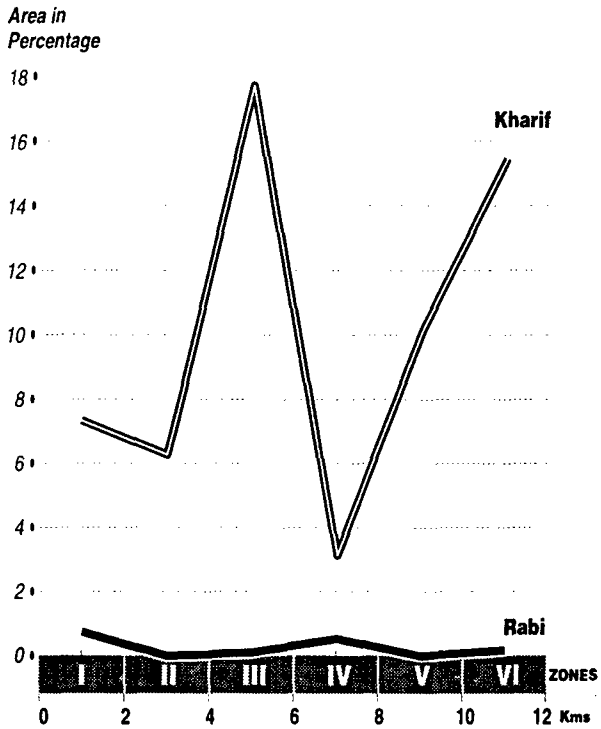
Fig-6.5.4A



FODDER

Parallel Zoning Along Patakpur Minor Canal
(1993-94)

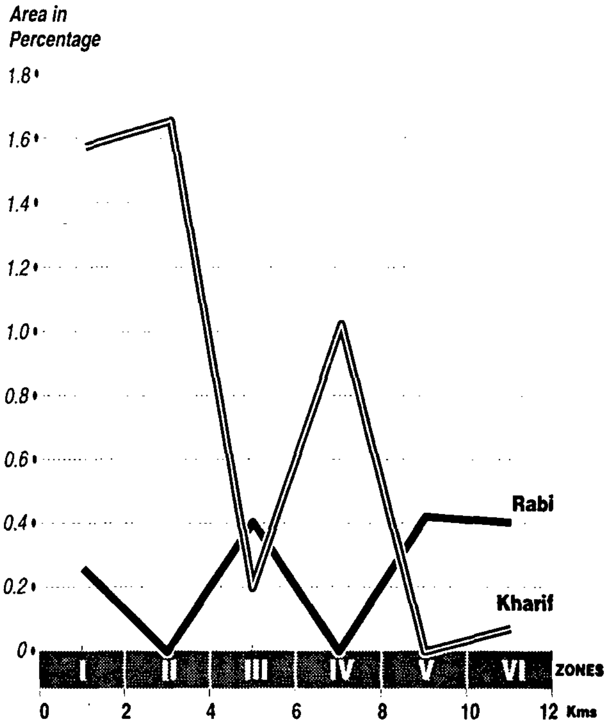
Fig-6.5.5A



PULSES

Parallel Zoning Along Patakpur Minor Canal
(1993-94)

Fig-6.5.6A



for want of statistical support. The reasons being the same as mentioned above in case of Kharif pulses.

In case of zoning along Patakpur Minor Distributary of Gurgaon Canal, the hypotheses which were statistically proved true and accepted were about Kharif and Rabi vegetables only. All other remaining crops/crop groups, however, could not justify, their respective hypotheses.

ANGULAR ZONING ABOUT SOHNA

(a) Cropping intensity and intensity of tube-well irrigation

The cropping intensity seems to bear a positive relationship with intensity of tube-well irrigation (Fig. 6.6.1A). The scatter plot with line of best fit (Fig. 6.6.1B) exhibits a rising trend of cropping intensity with increasing intensity of irrigation. A strong positive correlation of 0.961 along with a positive regression coefficient of 0.7049 seems to fall in line with the above statement.

The coefficient of determination of 0.9235 also indicates that 92.35% of the spatial variation in the cropping intensity is explained alone by irrigation intensity. The t-statitic of 6.183 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.01 level of significance. It means that the proportionate increase in the cropping intenstiy is real and is not due to chance.

In this convincing confirmation of the hypothesis, no overt economic consideration is involved. In fact, the intensity of irrigation along with quality of soils appear to be the major determinants of cropping intensity.

(b) Area under various categories of crops/crop groups (Rabi and Kharif) and the intensity of tube-well irrigation.

(i) Cereals (Kharif) - During the Kharif cropping season of 1993-94 in sampled villages of clock wise angular zones about Sonha the main cereal crops grown were, Bajra, Jowar, and paddy. Bajra occupied 67.19%, Jowar 24.65%, and paddy 8.16% of the net area put to the cultivation of all cereals of Kharif season.

The area under Kharif cereals is subjected to an alternate decrease and increase from Zone-I to Zone-VI (Fig. 6.6.2A). The scatter plot with least square line (Fig. 6.6.2B) seems to maintain an increasing trend with the intenstiy of tube-well irrigation. A strong positive correlatoin of 0.906 and a regression coefficient fo 0.621 also support the above statement.

The coefficient of determination of 0.8208 indicates that 82.08% of the spatial variation in the distribution of Kharif cereals is explained alone by irrigation intensity about Sohna. The t-statistic of 4.274 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.01 level of significance. It means that the proportionate increase in the distribution of Kharif cereals is real and is not due to chance.

Hence, the hypothesis that with increasing intensity of irrigation the area under Kharif cereals would decrease stands rejected. The Kharif cereals like Jowar and Bajra which are the crops of dry farming, require only small quantity of water as compared to those of Rabi cereals. Besides summer rains these crops appear to be dependent also upon tube-well irrigation. This fact is explained to some extent by high variability of rainfall (Table 1.4) for the blocks of Sohna, Taoru and Nuh. The sample villages for the study are taken from these blocks.

(ii) **Cereals (Rabi)** - During Rabi cropping season of 1993-94 in sampled villages only three cereal crops were grown. Wheat occupied 93.94%, barley 4.16% and gram 1.90% of the total area brought under the cultivation of Rabi cereals.

The area under cereals of Rabi cropping season is subjected to a sequence of decrease, increase, decrease, increase and increase right from Zone-I to Zone-VI (Fig. 6.6.2A) The minimum percentage of area lies in Zone-II (46.02%) and maximum in Zone-VI (82.83%). The scatter plot which depicts the least square line (Fig. 6.6.7B) parallel to abscissa states that there exists almost no relationship among the intensity of irrigation and the distribution of Rabi cereals. A weak correlation of -0.127 and a regression coefficient of -0.073 confirm the above statement.

Moreover, the coefficient of determination of 0.0161 indicates that only 1.61 percent of the spatial variation in the distribution of Rabi cereals is explained by irrigation intensity about Sohna. The t-statistic of 0.256 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It means that the proportionate decrease in the distribution of Rabi cereals is not real and is due to chance.

Hence, the hypothesis that with increasing intenstiy of irrigation, the area under cereals would increase, stands unaccepted in case of angular zoning about Sohna. The reason may be, that high yielding varieties of of wheat require much water supply for being grown, therefore, the areas which are having low or no irrigation facilities are unable to support the crop of wheat in the form of intensive commecial crop.

(iii) **Vegetables (Kharif)** - The area under Kharif vegetables is showing a sequential decrease, increase, decrease, increase, and decrease from Zone-I to Zone-VI (Fig. 6.6.3A). The scatter plot with line of best fit (Fig. 6.6.3B) shows an increasing trend with increasing intensity of irrigation. A strong positive correlation of 0.837 and a positive regression coefficient of 0.025 suggest that the above statement is true.

Moreover, the coefficient of determination of 0.7006 explain that 70.06% of the spatial variation in the distribution of Kharif vegetables is explained alone by irrigation intensity. The t-statistic of 3.060 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It implies that the proportionate distribution of Kharif vegetables is real and is not due to chance.

Hence, the hypothesis that with increasing intensity of tube-well irrigation, the distribution of vegetables would increase is accepted. Besides nearness to settlements which provide ready market, soil fertility and rainfall are also of great significance in defining the locational patterns of Kharif vegetables.

(iv) **Vegetables (Rabi)** - The area under the cultivation of Rabi vegetables in angular zones about Sohna lies in conformity with the intensity of irrigation from Zone-I to Zone-VI (Fig. 6.6.3A). The scatter plot with the line of best fit (Fig. 6.6.8B) also reveals that there exists a positive relationship among the intenstiy of irrigation and distribution of Rabi vegetables. A fairly strong positive correlation of 0.770 along with a positive regression coefficient of 0.053 confirms that above statement is true.

Moreover, the coefficient of determination of 0.5929 indicates that 59.29% of spatial variation in the distribution of Rabi vegetables is explained alone by irrigation intensity. The t-statistic of 2.407 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It implies that the proportionate increase in the distribution of Rabi vegetables is real and is not due to chance.

Hence, the hypothesis that with increasing intensity of tube-well irrigation the area under vegetables would increase is accepted. Besides nearness to a ready market the soil fertility, and assured water supply is of utmost significance as far as market gardening is concerned.

(v) **Oil Seeds (Kharif)** - The area under Kharif oil seeds viz-a-viz intensity of irrigation in each of the angular zone about Sohna seems to establish no trend of distribution (Fig. 6.6.4A). The scatter plot shows that the line of best fit (Fig. 6.6.4B) is almost parallel to abscissa which implies, that there exists almost no relationship between the distribution of Kharif oil seeds and intensity of irrigation. A very week negative correlation of -0.058 and a negative regression coefficient of -0.003 further supports the above mentioned statement.

Moreover, the coefficient of determination of 0.0034 indicates that only 0.34% of spatial variation in the distribution of Kharif oil seeds is explained by irrigation intensity. The t-statistic of 0.117 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is highly insignificant even at more than 0.05 level of significance. It implies that the proportionate increase in the distribution of Kharif oil seeds is not real and is due to chance.

Hence, the hypothesis that with increasing intensity of tube-well irrigation, the area under Kharif oil seeds would decrease is not acceptable for inadequate statistical support. Summer rainfall which is highly variable both over space and time sometimes help increasing the dependency of Kharif crops over irrigation.

(vi) **Oil seeds (Rabi)** - The area under oil seeds of Rabi cropping season shows a trend which is imperceptible and is rather confusing. In Zone-I, it occupies 24.12% area against the irrigation intensity of 24.38%, in Zone-II it occupies 45.0% area when the irrigation intenstiy is 35.64%. Similarly, Zones-III, IV, V and VI the area occupied by oil seeds is 17.87%, 24.32%, 23.62% and 3.00% as against the figures of irrigation intensity of 68.73%, 75.67%, 70.84% and 41.85% respectively (Fig. 6.6.4A). The scatter plot (Fig. 6.6.9B) with least square line shows neither an increasing nor a decreasing trend of the distribution of Rabi oil seeds. A very low negative correlation of -0.158 along with a negative regression coefficient of 0.099 confirms the above statement.

Moreover, the coefficient of determination of 0.0250 indicates that only 2.50 percent of spatial variation in the distribution of Rabi oil seeds is explained by irrigation intensity. The t-statistic of 0.321 of the regression coefficient with 4 degrees of freedom verifies that the regression coefficient is insignificant even at more than 0.05 level of significance and therefore, the proportionate decrease in the distribution of Rabi oil seeds is perhaps not real and is due to chance.

Hence, the hypothesis that with increasing intensity of tube-well irrigation, the area under Rabi oil seeds would decrease is not acceptable. Oil seed crops are less water demanding, therefore, these crops do not rely much upon irrigation.

(vii) **Fodder (Kahrif)** - The area under Kharif fodder in angular zones about Sohna reveals that there exists a weak positive relationship among the intensity of tube-well irrigation and distribution of Kharif fodder (Fig. 6.6.5A). The scatter plot with line of best fit (Fig. 6.6.5B) also represents the same distributional patterns as mentioned above. A weak positive correlation of 0.292 and a positive regression coefficient of 0.072 further support the above mentioned statement.

Moreover, the coefficient of determination of 0.0853 indicates that only 8.53 percent of spatial variation in the distribution of Kharif fodder is explained by irrigation intensity. The t-statistic of 0.610 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It implies that the proportionate increase in the distribution of Kharif fodder is not real and is due to chance.

Hence, the hypothesis that with increasing intensity of irrigation, the area under Kharif fodder will decrease is not accepted. Since, fodder crops of Kharif season on account of summer rains do not depend much upon irrigation. It can, therefore, be argued that tube-well irrigation plays a little role in the locational behaviour of Kharif fodder crops.

(viii) **Fodder (Rabi)** - The area under Rabi fodder seems to have either no or very weak relationship with the intensity of irrigation (Fig. 6.6.5A). It increases from 0.66% in Zone-1 to 2.13% in Zone-II, then it is subjected to a decrease, and it decreases to 1.74% in Zone-III. In Zone-IV it again rises to 3.38% and then decreases to 0.92% and 0.43% in Zone-V and VI respectively. These fluctuations in the distribution of Rabi fodder are explained against the values for irrigation intensity of 24.38%, 35.64%, 68.73%, 75.67%, 70.84%, and 41.85% respectively. The scatter plot with the line of best fit (Fig. 6.6.10B) shows an average rise in the distribution of Rabi fodder with increasing intensity of irrigation. However, this rising trend is not supported by a moderate correlation of 0.511 and a regression coefficient of 0.026.

Moreover, the coefficient of determination of 0.2611 indicates that only 26.11 percent of spatial variation in the distribution of Rabi fodder is explained by irrigation intensity. The t-statistic of 1.190 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It implies that the proportionate increase in the distribution of Rabi fodder is not real and is due to chance.

Hence, the hypothesis that area under fodder crops decreases with increasing intensity of irrigation is not proved true and is, therefore, not accepted. In fact fodder crops are less water demanding. It tells about their distribution which is not very much affected by variations in irrigation facilities.

(ix) **Pulses (Kharif)** - Examination of the graph (Fig. 6.6.6A) shows that the area under pulses of Kharif cropping season seems to bear a weak relationship with the intensity of irrigation. The scatter plot with line of least square also shows an average increasing trend (Fig. 6.6.6B). Which is midly supported by a correlation of 0.611 and a regression coefficient of 0.020.

The coefficient of determination of 0.3733 indicates that only 37.33% of spatial variation in the distribution of Kharif pulses is explained by irrigation intensity. The t-statistic of 1.527 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is not significant even at more than 0.05 level of significance. It implies that the proportionate distribution of Kharif pulses is not real and is due to chance.

Hence, the hypothesis that area under pulses would decrease with increasing intensity of irrigation is not accepted. Since irrigation is not of much significance as far as cultivation of pulses in Kharif season is concerned, choice of the parcel of land, to grow pulses depends much upon the decision of the farmer as well as market impulses.

(x) **Pulses (Rabi)** - The distribution of Rabi pulses and intensity of irrigation in case of angular zoning about Sohna shows a continuous increase upto Zone-IV, (Fig. 6.6.6A). It decreases in Zone-V and VI. The scatter plot with least square line (Fig. 6.6.11B) also exhibits a positive increasing trend. This observations of increasing trend is not supported by the statistics of correlation and regression. There exists a weak correlation (0.468) among the numerals of the distribution of pulses and irrigation intensity. The regression coefficient was worked out to be 0.028.

Moreover, the coefficient of determination of 0.2190 indicates that only 21.90 percent of spatial variation in the distribution of Rabi pulses is explained by irrigation intensity in conical zones about Sohna. The t-statistic of 1.056 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It implies that the proportionate increase in the distribution of Rabi pulses is not real and is due to chance.

Hence, the hypothesis, that area under pulses would decrease with increasing intensity of irrigation is not acceptable in the light of above mentioned statistical findings. This states that farmers decision to grow a particular crop at a particular location becomes more significant particularly in the case of less preferred crops like pulses.

In case of angular zoning about Sohna, the hypotheses which were statistically proved and accepted were about, cropping intensity, Kharif and Rabi vegetables. All other remaining crops/crop groups, however, could not validate their respective hypotheses.

ANGULAR ZONING ABOUT NAGINA

(a) Cropping intensity and intensity of tube-well irrigation.

The cropping intensity and the intensity of irrigation seems to bear a positive relationship (Fig. 6.7.1A). In every angular zone about Nagina for a rise in the intensity of irrigation, there is also an increase in cropping intensity. The scatter plot with least square line (Fig. 6.7.1B) also exhibits a rising trend. The correlation coefficient of 0.888 and the regression coeffecient of 0.603 further support the above observation.

Moreover, the coefficient of determination of 0.7885 indicates that 78.85 percent of spatial variation in the cropping intensity is explained alone

Locational Patterns of Cropping and Intensity of Irrigation in Angular Zones About Sohna
(1993-94)

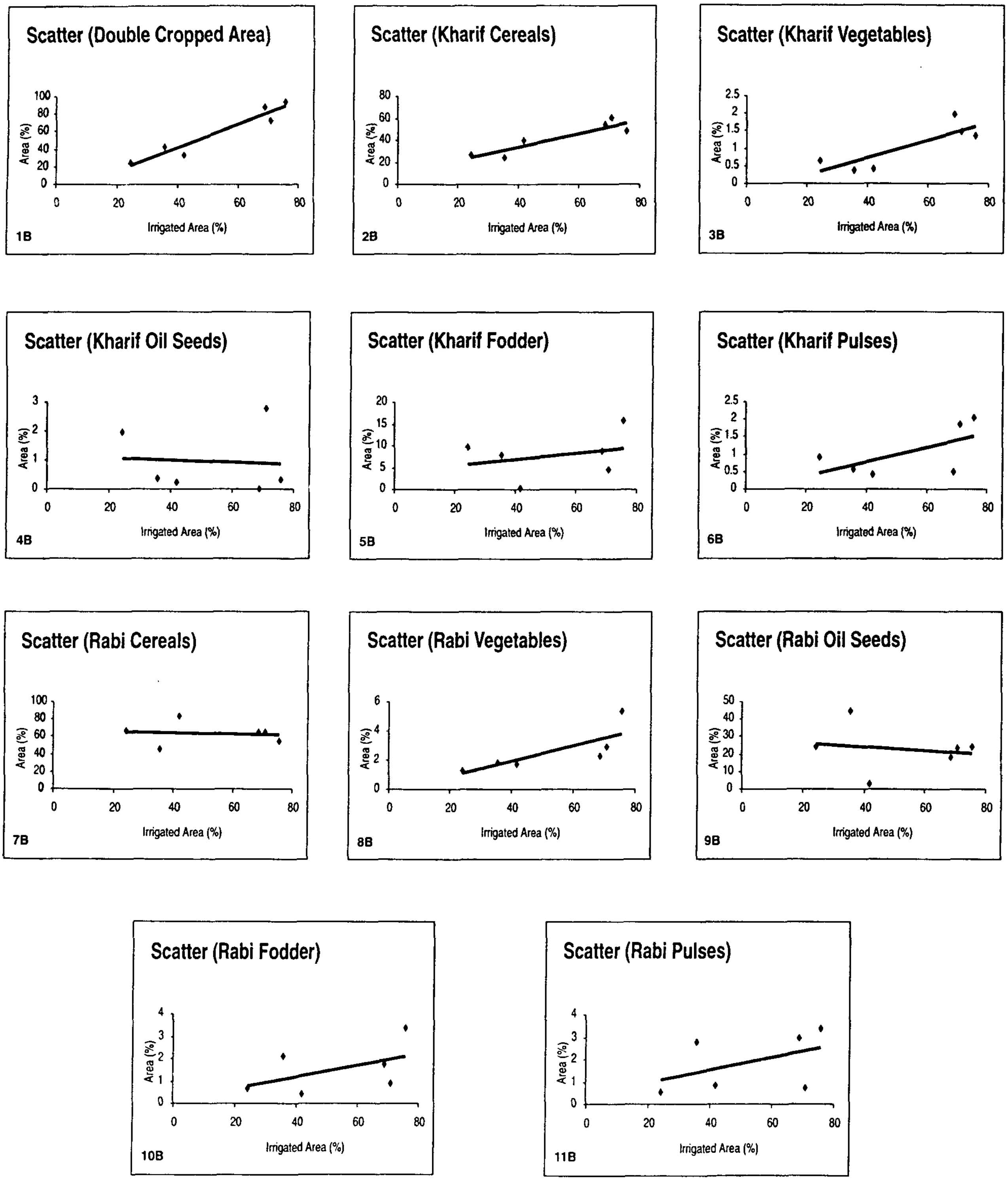
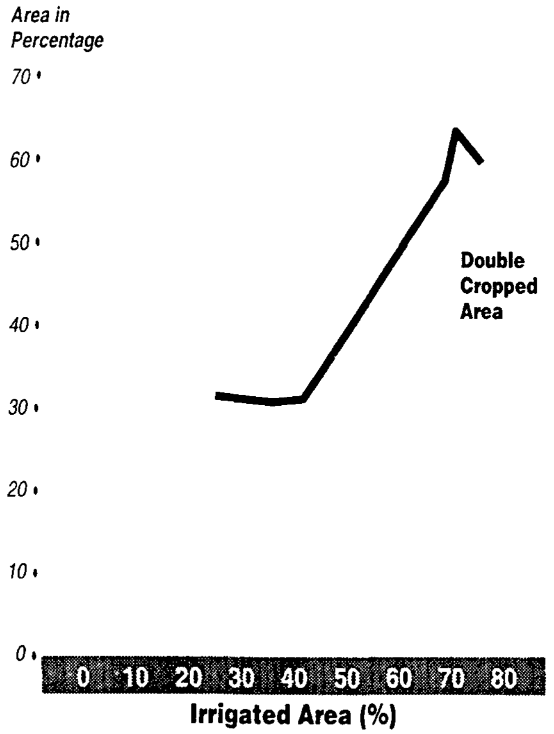


Fig. 6.6

INTENSITY OF CROPPING AND IRRIGATION

Angular Zoning About Sohna
(1993-94)

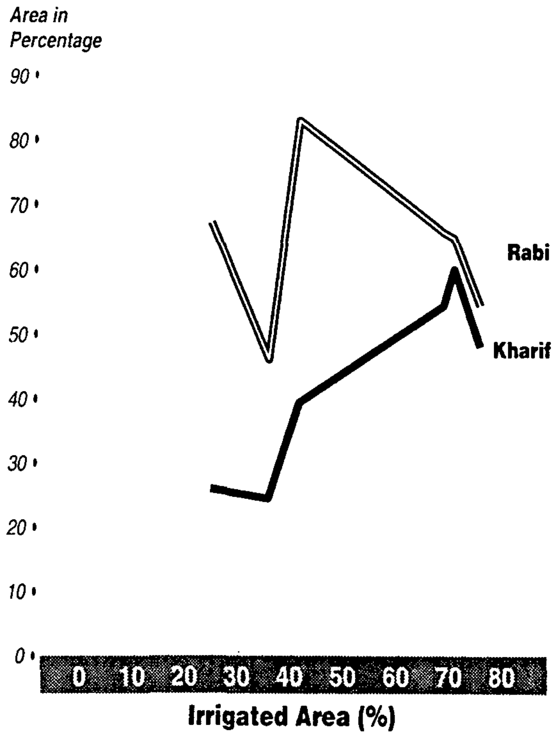
Fig-6.6.1A



CEREAL CROPS

Angular Zoning About Sohna
(1993-94)

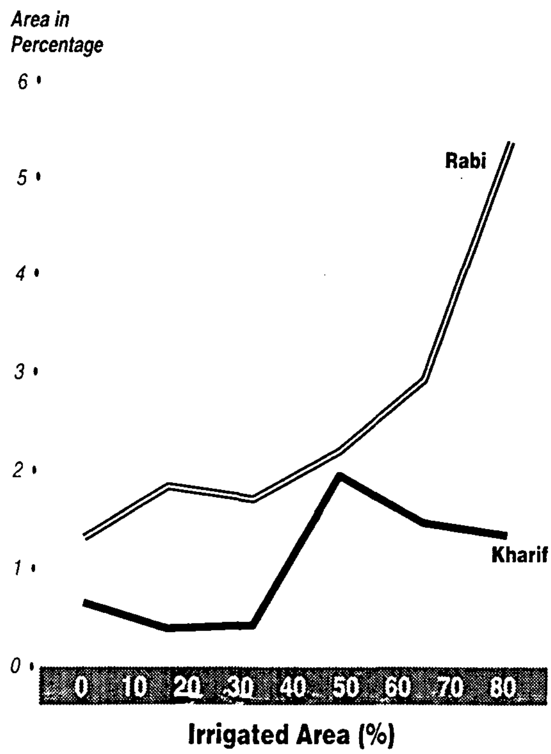
Fig-6.6.2A



VEGETABLES

Angular Zoning About Sohna
(1993-94)

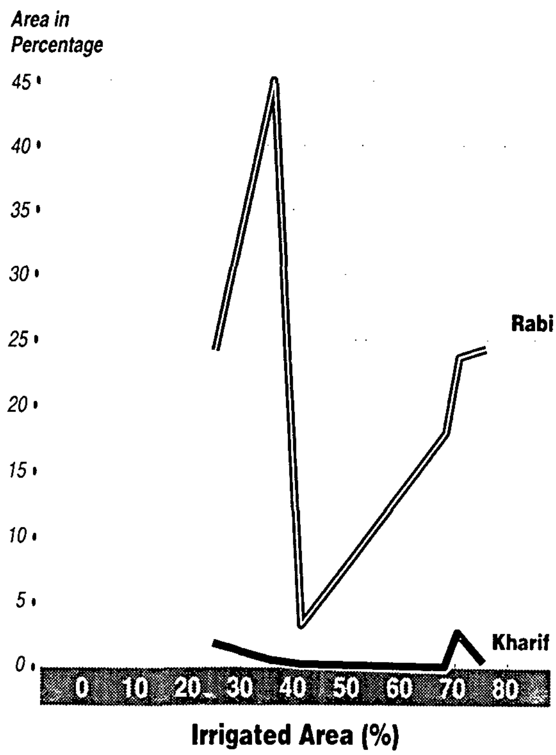
Fig-6.6.3A



OIL SEEDS

Angular Zoning About Sohna
(1993-94)

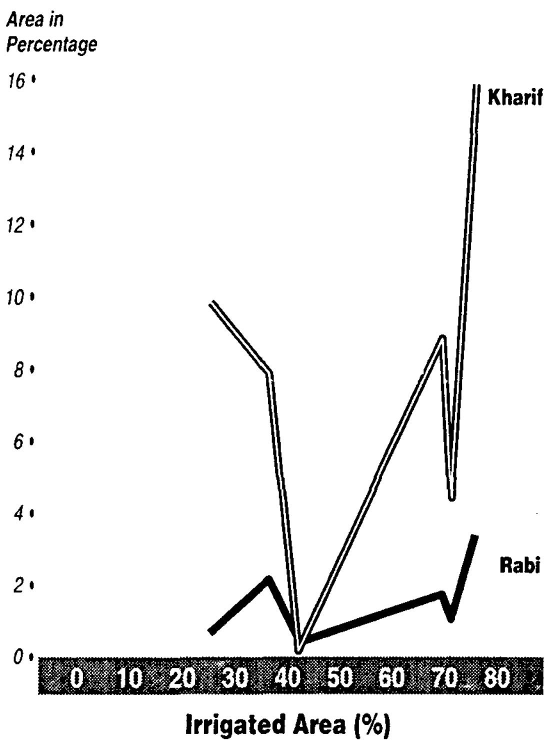
Fig-6.6.4A



FODDER

Angular Zoning About Sohna
(1993-94)

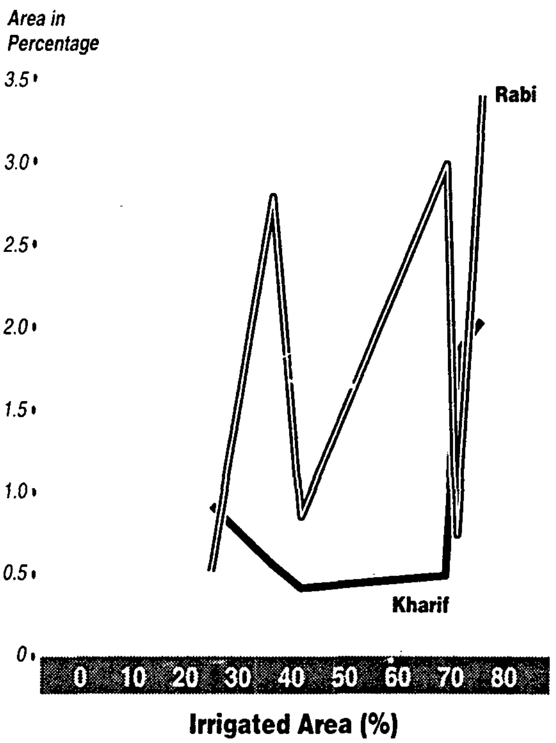
Fig-6.6.5A



PULSES

Angular Zoning About Sohna
(1993-94)

Fig-6.6.6A



by irrigation intensity in angular zones about Nagina. The t-statistic of 3.331 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It means that the proportionate increase in the cropping intensity is real and is not due to chance.

Irrigation is the most important ingradient for the present day agriculture, specially for double cropping in semi-arid climatic conditions. On the mercy of rainfall which is received maximum in the form of summer rains intensification of agriculture to a great extent seems to be impossible. Hence, the hypothesis that with increasing intensity of irrigation intensity of cropping would increase is accepted.

(b) Area under various categories of crops/crop groups (Rabi and Kharif) and the intensity of tube-well irrigation

(i) **Cereals (Kharif)** - During the Kharif cropping season of 1993-94 in sampled villages the main cereal crops grown were only Jowar and Bajra. Jowar was cropped over 56.04% and Bajra over 43.96% of the total area put to the cultivation of Kharif cereals.

The area under cereals of Kharif corpping season is subjected to a sequence of decrease (22.42%), decrease (11.86%), increase (22.78%), increase (23.46%), and increase (32.69%) as aganist the intensity of irrigation which is showing a sequence of increase (18.38%), decrease (3.71%), increase (27.0%), increase (33.38%) and increase (65.09%) in corresponding zones (Fig. 6.7.2A). The scatter plot with least square line (Fig. 6.7.2B) exhibits an average increasing trend of cropping intensity with respect to intensity of irrigation. A weak positive correlation of

0.468 with a positive regression coefficient of 0.149 also favours the above statement.

Moreover, the coefficient of determination of 0.2190 indicates that only 21.90% of spatial variation in the distribution of Kharif cereals is explained by irrigation intensity in angular zones about Nagina. The t-statistic of 1.060 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is not significant at even more than 0.05 level of significance. It means that the proportionate increase in the distribution of Kharif cereals is not real and is due to chance.

For the lack of statistical support, the hypothesis, that with increasing intensity of irrigation the area under Kharif cereals would decrease in the case of angular zones about Nagina stands rejected. Around Nagina, the sub-soil water in extensive area is saline, which is hardly suitable for irrigation purposes. The water in the form of summer rains therefore, plays a crucial role in determining the location and concentration of crops.

(ii) **Cereals (Rabi)** - During the Rabi cropping season of 1993-94 in sampled villages only three cereal crops were grown. Wheat occupied 71.71%, gram 23.80% and barley 4.49% of the net area put to the cultivation of Rabi cereals. The area under cereals of Rabi cropping season and intensity of tube-well irrigation appear to have no apparent relationship (Fig. 6.7.2A). The scatter plot with least square line (Fig. 6.7.7B) represents an average increasing trend of the distribution of Rabi cereals which is rather confused. A weak correlation of 0.349 and a regression coefficient of 0.135 extend a weak support to the above statement.

Moreover, the coefficient of determination of 0.1218 indicates that only 12.18 percent of the spatial variation in the distribution of Rabi cereals is explained by irrigation intensity, in angular zones about Nagina. The t-statistic of 0.745 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It means that hypothesised distribution of Rabi cereals is not real is due to chance.

Hence, the hypothesis that with increasing intensity of irrigation, the area under Rabi cereals would increase stands unaccepted for want of proper statistical support. Under rainfed agriculture, tube-well irrigation becomes more significant. Thus, location of tube-wells determine the location of cereal crops. Since, wheat, the dominant Rabi cereal crop of the region, the high yielding varieties of which require several waterings during its field life, is affected by the quality and quantity of water supply. However, a weak trend in favour of hypothesis is observed.

(iii) **Vegetables (Kharif)** - The area under Kharif vegetables is showing an increasing trend with respect to increasing intensity of irrigation from Zone-I to Zone-VI (Fig. 6.7.3A) with the exception of zones-II, III and V where, there is a decline in the area of vegetables. The scatter plot with least square line (Fig. 6.7.3B) also exhibits the same rising trend. This statement of rising trend in the distribution of Kharif vegetables is supported by a positive ccorrelation of 0.868 and a positive regression coefficient of 0.059.

Moreover, the coefficient of determination of 0.7534 indicates that 75.34 percent of the spatial variation in the distribution of Kharif vegetables is explained alone by irrigation intensity in angular zones about Nagina.

The t-statistic of 3.497 of the regression coefficient with 4 degress of freedom shows that the regression coefficient is significant at less than 0.05 levels of significance. It implies that the proportionate distribution of Kharif vegetables is real and is not due to chance.

Besides soil fertility, nearness to a market place and demand for vegetables, and the assured water supply through rainfall or irrigation are the most important inputs which determine the location of vegetables in angular zones about Nagina. Hence, the hypothesis that with increasing intensity of tube-well irrigation, the area under vegetables increases, is accepted in this case.

(iv) Vegetables (Rabi) - The area under Rabi vegetabels with respect to intensity of irrigation does not show any strong relationship (Fig. 6.7.3A). The scatter plot with least square line (Fig. 6.7.8B) also exhibits a confusing trend. A weak negative correlation of -0.247 and a negative regression coefficient of -0.023 support the above mentioned statement.

Moreover, the coefficient of determination of 0.0610 indicates that only 6.10% of the spatial variation in distribution of Rabi vegetables is explained by irrigation intensity in angular zones about Nagina. The t-statistic of 0.508 of the regression coefficient is insignificant even at more than 0.05 level of significance. It implies that the proportionate decrease in the distribution of Rabi vegetables is not real and is due to chance.

Hence, the hypothesis that with increasing intensity of irrigation, the area under vegetables would incerase is not accepted in this case for the lack of proper statistical support. Rajaka, the only sampled village perhaps caters to the needs of vegetables for the population of Nagina to a great extent. Hence, this village (Zone-1) as a whole is the leading vegetables producer in both Kharif and Rabi cropping seasons. The more area allocated to vegetables in Zones-IV, V and VI is apparently attributed to higher percentage of tube-well irrigation in respective zones. However, in case of angular zoning about Nagina, other factors like nearness to a market place and fertility of the soils, are significant in determining the locational patterns of vegetables.

(v) **Oil Seeds (Kharif)** - The area under oil seeds of Kharif cropping season in angular zones about Nagina and the intensity of cropping show a close relationship (Fig.. 6.7.4A). The scatter plot with least square line (Fig. 6.7.4B) shows a steep rising trend. A correlation of 0.969 and a regression coefficient of 0.04 states that there exists a very strong relatioship between the area under oil seeds and irrigation intensity.

Moreover, the coefficient of determination of 0.9390 indicates that 93.90% of spatial variation in the distribution of Kharif oil seeds is explained alone by irrigation intensity in angular zones about Nagina. The t-statistic of 7.821 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.01 level of significance. It implies that the proportionate distribution of Kharif oil seeds is real and is not due to chance.

Hence, the hypothesis that with increasing intensity of irrigation the area under oil seeds would decrease stands rejected in this case. However, this rejection of hypothesis on solid statistical ground, but is misleading. Since, oil seeds are less water demanding crops, moreover, the summer mansoon brings sufficient amount of water required for the cultivation of these oil seeds. Hence, this statistical trend in case of Kharif oil seeds should not be given much weightage. The impact of tube-well irrigation on the location of oil seeds in Kharif season is therefore, not very much prominent in the face of summer monsoon rains.

(vi) **Oil seeds (Rabi)** - The area under oil seeds of Rabi cropping season in angular zones about Nagina and irrigation intensity do not represent any strong relatioship (Fig. 6.7.4A). The scatter plot with least square line (Fig. 6.7.9B) also represents a confused trend with line of best fit lying almost parallel to abscissa. The correlation of -0.149, and the regression coefficient of -0.070 also favour the above observation.

Moreover, the coefficient of determination of 0.0222 indicates that only 2.22% of spatial variation in the distribution of Rabi oil seeds is explained by irrigation intensity among the angular zones about Nagina. The t-statistic of 0.302 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is not significant even at more than 0.05 level of significance. It implies that the proportionate decrease in the distribution of Rabi oil seeds is not real and is due to chance.

Hence, the hypothesis that with increasing intensity of irrigation, the area under oil seeds would decrease, stands rejected for inadequate statistical support. This rejection of the hypothesis tells about economic motive which is involved. The crops of oil seeds as a part of commercial farming are governed by market driven forces. A good market price for mustard/rape seed fascinate farmers and invite them to go for the cultivation of these crops. This is very much evident from the acreage statistics. In every angular zone about Nagina, oil seeds rank first among all crops/crop groups.

(vii) **Fodder (Kharif)** - The area under fodder crops of Kharif cropping season and the intensity of the irrigation seem to have very strong positive bonds of relationship (Fig. 6.7.5A). The scatter plot with least square line (Fig. 6.7.5B) also exhibits a rising trend of the area under fodder crops and increasing intensity of tube-well irrigation. The above statement is strongly supported by a strong positive correlation of 0.775 and a regression coefficient 0.163.

Moreover, the coefficient of determination of 0.6006 indicates that 60.06% of the spatial variation in the distribution of Kharif fodder is explained alone by irrigation intensity among the angular zones about Nagina. The t-statistic of 2.450 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It implies that the proportionate distribution of Kharif fodder is real and is not due to chance.

Hence, the hypothesis that with increasing intensity of irrigation, the area under fodder crops would decrease stands rejected. During Kharif season when summer rainfall levels out the variations in irrigation intensity and moreover, when the sub-soil water is not suitable for irrigation in most of the areas around Nagina, the emphasis of the farmers is naturally more on the cultivation of fodder in Kharif rather than in Rabi season. The emerged strong positive relationship between the irrigation intensity and fodder distribution is beyond therefore, reality.

(viii) **Fodder (Rabi)** - The area under Rabi fodder and irrigation intensity do not show any close relationship which are obvious from the examination of area and irrigation curves (Fig. 6.7.5A) as well as percentage figures of the two variables. The scatter plot with the line of best fit (Fig.

6.7.10B) represents a confused picture of the trend of distribution of Rabi fodder and irrigation intensity. A weak negative correlation of -0.398 along with a negative regression coefficient further supports the above mentioned statement.

Moreover, the coefficient of determination of 0.1584 indicates that only 15.84% of the spatial variation in the distribution of Rabi fodder is explained by irrigation intensity in angular zones about Nagina. The t-statistic of 0.869 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is not significant even at more than 0.05 level of significance. It implies that the proportionate decrease in the distribution of Rabi fodder is not real and is due to chance.

Hence, the hypothesis that with increasing intensity of irrigation the area under Rabi fodder would decrease is not accepted for want of statistical support. Since, fodder crops are not much dependent upon irrigation, therefore, a weak bond between irrigation intensity and distribution of fodder is not surprising.

(ix) **Pulses (Kharif)** - The analysis of the area under pulses of Kharif cropping season of 1993-94 in angular zones about Nagina and the intensity of tube-well irrigation is not carried out since a very small area (0.54%) is devoted to the cultivation of pulses only in Zone-II, while all other zones are not having any area under pulses.

(x) **Pulses (Rabi)** - The area under pulses of Rabi cropping season in angular zones about Nagina and the cropping intensity (Fig. 6.7.6A) reveals that there seems to exist an average relationship among the two variables which is not very much obvious and is rather confused. The least square line (Fig. 6.7.11B) also shows a general declining and confusing trend of the distribution of Rabi pulses. A weak negative correlation of -0.460 along with a negative regression coefficient further supports the above observation.

Moreover, the coefficient of determination of 0.2116 indicates that only 21.16% of the spatial variation in the distribution of Rabi pulses is explained by irrigation intensity in angular zones about Nagina. The t-statistic of 1.038 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is not significant even at more than 0.05 level of significance. It implies that the proportionate distribution of Rabi pulses is not real and is due to chance.

Hence, the hypothesis that with increasing intensity of irrigation the area under pulses would decrease is not acceptable for the lack of proper statistical support. It implies that there are some factors other than irrigation like fertility of the soil and farmers' decision which are more answerable for the location of pulses in this part of the study area.

In case of angular zoning about Nagina, the hypotheses which were accepted and proved valid on statistical ground were about cropping intensity and Kharif vegetables only. All other crops/crop groups, however, failed to justify their respective hypotheses.

Appendix-X summarises the results of statistical testing of formulated hypotheses at macro-level following Von Thunens model of agricultural landuse. It is interesting to note that in majority of cases the hypotheses are not accepted. In many such cases it is found out that the

Locational Patterns of Cropping and Intensity of Irrigation in Angular Zones About Nagina

(1993-94)

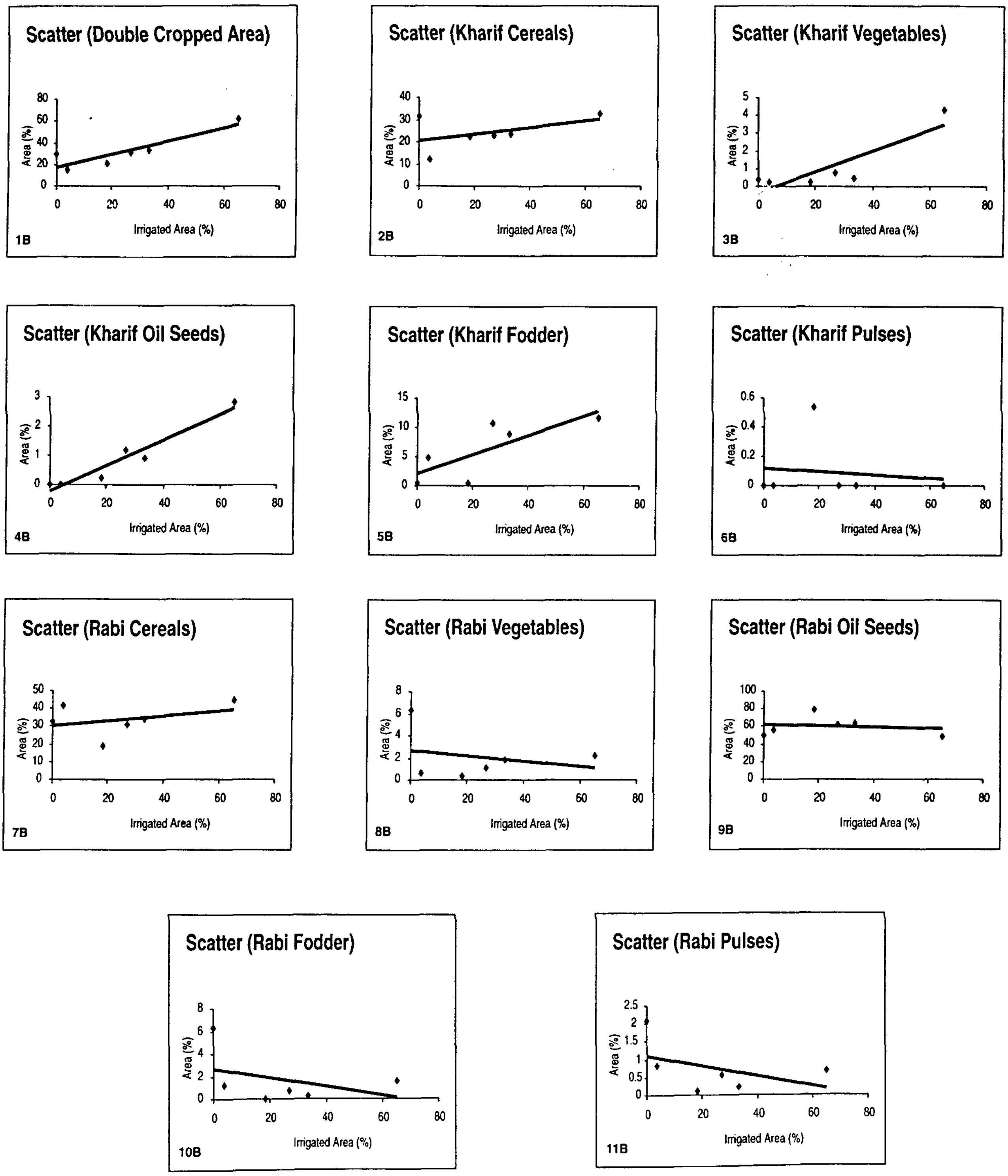
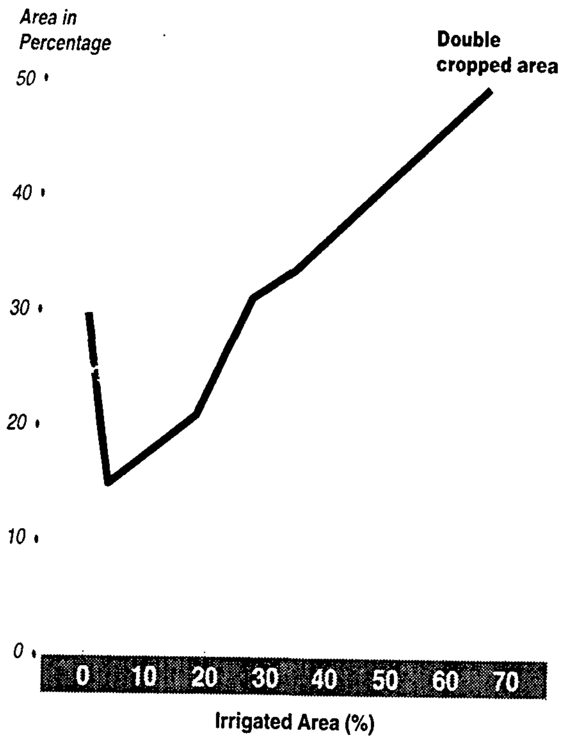


Fig. 6.7

INTENSITY OF CROPPING AND IRRIGATION

Angular Zoning About Nagina
(1993-94)

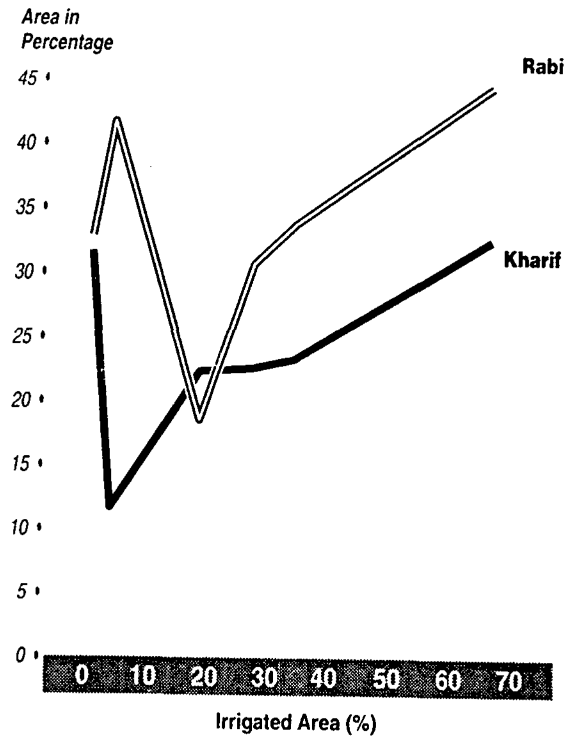
Fig-6.7.1A



CEREAL CROPS

Angular Zoning About Nagina
(1993-94)

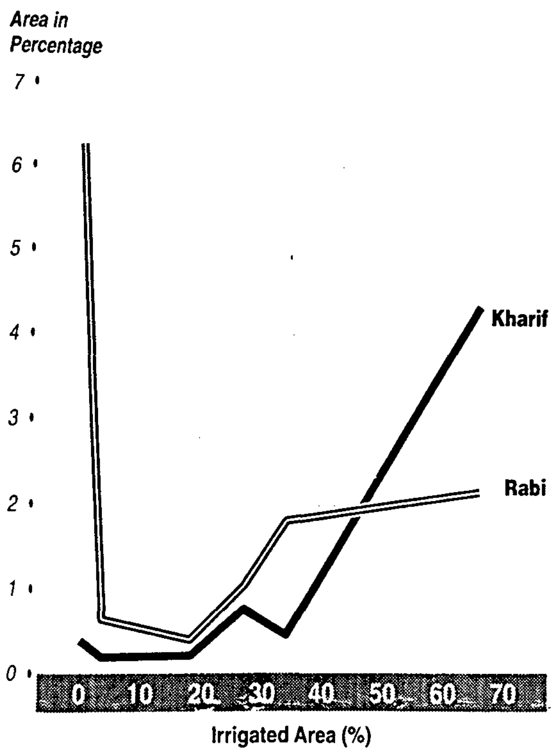
Fig-6.7.2A



VEGETABLES

Angular Zoning About Nagina
(1993-94)

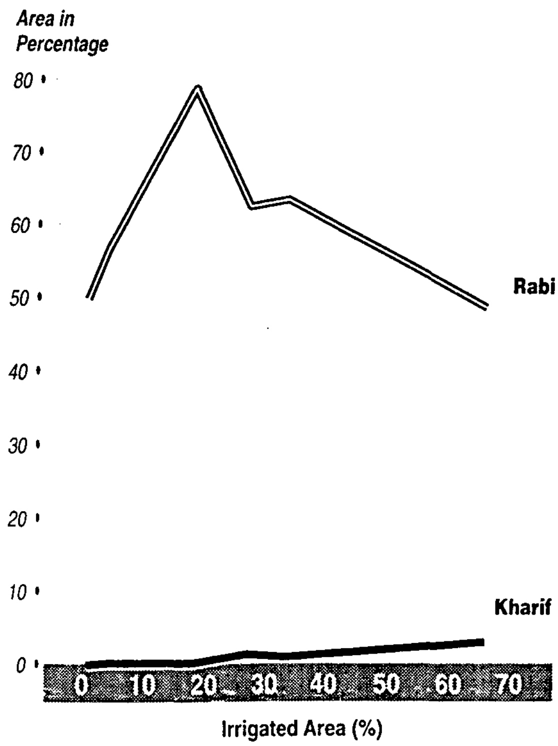
Fig-6.7.3A



OIL SEEDS

Angular Zoning About Nagina
(1993-94)

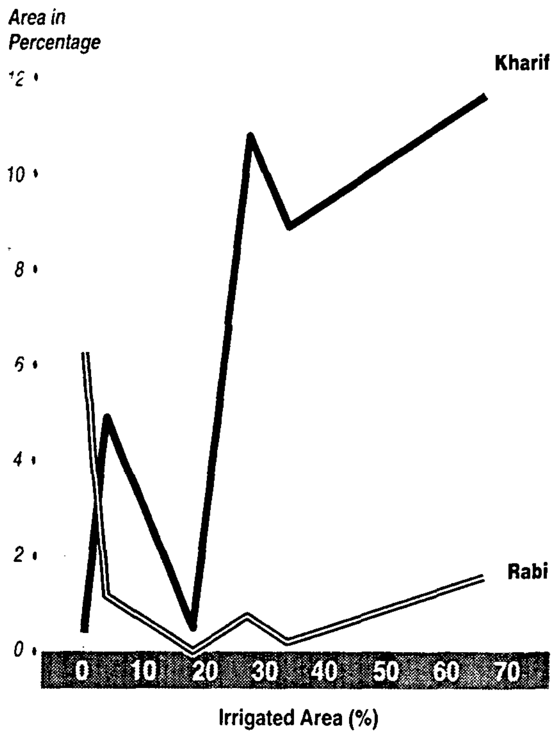
Fig-6.7.4A



FODDER

Angular Zoning About Nagina
(1993-94)

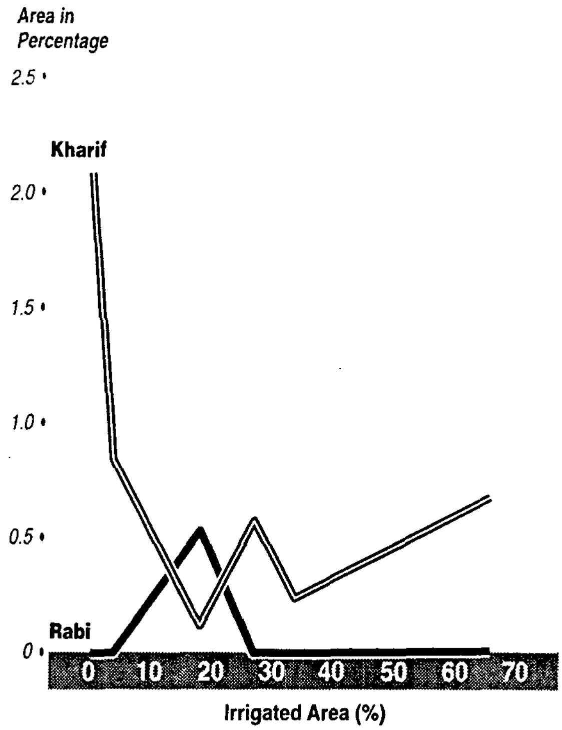
Fig-6.7.5A



PULSES

Angular Zoning About Nagina
(1993-94)

Fig-6.7.6A



trends, though in conformity with the formulated hypotheses, is rejected for want of statistical support. It has happened in twentysix cases out of seventyseven. The hypotheses turned about true are nineteen. Thus, in about 25% cases, the hypotheses seem to be correct. However, in 30% cases the observed trend is opposite to that perceived in the formulated hypotheses. A total of twentynine cases in which opposite trend is observed, twentythree show a trend which is not statistically sound. In three cases hypotheses are not tested on account of paucity of data.

The main findings of this chapter are presented below.

1. The intensity of cropping as per the formulated hypothesis increases with increasing intensity of irrigation about Sohna and Nagina only. While in other cases, like distance from the canal, urban centres of Gurgaon and Nuh and the lines of communication - railway and highway, the proposition does not stand valid statistically. However, in case of increasing distance from Nuh, Delhi-Jaipur railway and canal with in adequate statistical support the trend of cropping intensity is in conformity with the proposition.

2. The acreage of cereals, oil seeds and pulses would increase with distance from Gurgaon, Nuh, railway, road and canal is proved true statistically only in case of highway (Kharif cereals and pulses), distance from Gurgaon (Rabi cereals and pulses) only. Statistically invalid trend but in conformity with the respective hypotheses are found in the cases of Kharif cereals (around Gurgaon and Nuh), Kharif oil seeds (around Gurgaon and Nuh, along highway), cereals Rabi (around Nuh, along railway, highway and canal), Rabi oil seeds (around Gurgaon and Nuh), and Rabi pulses (along canal). The rest of the hypotheses are either

rejected for sound statistical reasons like that of Kharif pulses (around Gurgaon) or they are not accepted for weak statistical support and opposite trends like Kharif cereals (along railway and canal), Kharif oil seeds (along railway and canal), Kharif pulses (around Nuh, and along canal), Rabi oil seeds (along railway, highway and canal), and Rabi pulses (around Nuh and, along highway).

3. The acreage of vegetables would decrease with respect to Gurgaon, Nuh, railway, highway and canal as well as would increase with increasing irrigation intensity is proved statistically true, in case of Kharif vegetables (around Nuh, along canal, about Sohna and Nagina) and in case of Rabi vegetables (around Gurgaon and Nuh along highway and canal, and about Sohna). Statistically insignificant but with a trend lying in conformity with the respective proposition is found for Kharif vegetables (around Gurgaon and along railway), and for Rabi vegetables (along railway) only.

4. The distribution of fodder crops would decrease with distance from urban settlements (Gurgaon and Nuh), railway, highway, canal and irrigation intensity in zones about Sohna and Nagina is found true only in case of Kharif fodder (around Gurgaon and Nuh, and for Rabi fodder (around Gurgaon, along railway and highway). A weak statistical support for a favourable trend is observed in case of Kharif fodder (along highway), and for Rabi fodder (around Gurgaon, and along railway and highway). Statistically weak and opposite trend is found in case of Kharif fodder (along railway, canal and about Sohna), and Rabi fodder (along canal and about Sohna). This hypothesis on sound statistical grounds is rejected only in the case of angular zoning about Nagina.

From the above findings it is noted that cropping intensity, vegetables and fodder crops show a trend which in many cases is in conformity with the hypotheses proposed. In those cases where the influence of urban makets is not observed or the trend is opposite to that perceived in hypotheses is not a weakness of the model under investigation. First thing that emerges is that, the area under study does not qualify as an Isolated State, secondly, the region is not isotropic. Thirdly, there are operating certain other factors of the modern times whcih have definite influence on agricultural landuse pattern. For instance, a vast area in proximity of Gurgaon is not cultivated as it is left for urban development. This has a sound effect on cropping intensity, and vegetable production. These vacant pacels of land show an opposite or weak tendency of farming. All these factors are responsible for the observed trends of farming practices in the region. It may, therefore, be concluded with confidence that given the premises of Von Thunen's model, the cropping intensity, vegetables and fodder crops would show a trend of cultivation in close conformity with the model. However, in other crop groups such as cereals, oil seeds and pulses it can not be concluded with the same conviction.

The transport is also observed to have some influence on the cropping pattern. In the case of railway, only one out of eleven variables show a satisfactory confirmation of the hypothesis which may be considered as, due to chance. The fact is, that railways are not as accessible to the villagers as the roads are, because, there are few stations/halts where the trains stop. Therefore, it has a negligible impact on the cropping patterns as the means of transportation. On the other hand, roads are observed to make a perceptible impact on cropping as in case of four out of eleven variables, the hypotheses are confirmed true, and in another three cases the trend is observed in accordance with the hypotheses with no proper statistical support. Hence, it may be argued that road accessibilty has some influence on the cropping pattern in the region with respect to model tested here.

It seems interesting to note that the alternative explanation to the Von Thunen's model i.e. irrigation, apparently does not emerges as significant as it has been assumed. In the case of irrigation by canal only two out of eleven hypotheses are confirmed true statistically, and only four show a trend in favour of the hypotheses, while four show an inverse trend and one is rejected on firm statistics. This situation is perhaps on account of seasonal nature of the canal which remains dry in other than rainy season. The evidence regarding any impact if any, of tube-well irrigation tested, about Sohna and Nagina appears as weak as that in the case of canal irrigation. Therefore, it may be concluded with confidence that irrigation has little impact on cropping pattern in the region and can be taken with some reservations, as an alternative explanation to the model of Von Thunen.

From the above discussion, it can not be concluded that at regional level Von Thunen's model can be rejected. The fact is that its weakness does not comes out from its arguments but from its assumptions and premises. In an old settled region like Gurgaon the isotropism does not obtain. Further, it may also be noted that morphology of economic rent is not determined by transport cost alone. There are certain other factors like quality and type of soil, and availability of water that determine the economic rent of a piece of land. Further, the type of agriculture also plays an important role in shaping crop landuse. The Von Thunen's model is based on the assumption of commercial farming where the farmer is interested in maximising his profit. This situation does not obtain in the region under investigation. Due to dry conditions, in major part of the region a subsistence type of farming prevails and in parts where it is commercialised, a large part of the produce is consumed in homes and very small appears in the market. This makes a great difference and that is why, that a large number of hypotheses based on the Von Thunen's model are not confirmed. Therefore, it can be concluded safely that Von Thunen's model can not be rejected at hand. It has its value as a basic pattern underlined crop landuse and deviations from it need careful explanation within the model.

CHAPTER - VII

TESTING OF VON THUNEN'S MODEL IN GURGAON DISTRICT AT MICRO-LEVEL

This chapter has its purpose to analyse locational pattern of landuse at micro-level i.e., village level. It is interesting to point out that Von Thunen's model is relevant only at macro-level ie. regional level, even then the researchers assessing this model have also tested it at micro-level i.e., village level. It has been also an stimulant in the present case. Therefore, in the following pages an attempt is made to test some of the propositions derived from the von Thunen's model at village level.

Basic to the Von Thunen's model is the concept of rent that determines value of land. This in turn is determined by the location with respect to market or in other words transportation cost which generates morphology of rent and therefore determine the landuse and intensity of agriculture. At micro-level this concept of rent is not applicable as transportation cost from the farm to the village settlement is not much significant in decision making. What is important is the fact of the quality of soil, source of irrigation and tendency of least effort on the part of farmers. The first and the last factor generate a morphology of rent that make rings around the village settlement in the case of compact villages. As, in Indian conditions villagers rate the quality of land as decreasing away from the settlement, and therefore, its value decreases with distance from the settlement. The land adjacent to the settlement has the highest value that decreases away from settlement. This pattern of circular zones around village settlement in Indian conditions is greatly modified by the presence of the source of irrigation, as land near the canal or tube-wells also has high value.

Hence, this pattern of rent may be hypothesised to bear on the cropping intensity as well as crop preferences in different zones around the village settlement. It may be hypothesised that intensive use of land would decrease away from the settlement and irrigation source. The cropping intensity may decrease with distance while share of the extensively grown crops (with minimum monetary inputs) may increase. The hypotheses based on this derivative of von Thunen are formulated in Introduction and are tested in the following pages. For this purpose six villages namely Gumet Bihari of Nagina block, Sewka of Taoru block, Balola of Sohna block, Iqbalpur of Farrukhnagar block, Karamchandpur of Nuh block, and Silokhra of Gurgaon block are picked up after purposive sampling.

Gumat Bihari was selected for studying the location of crops in a rainfed agriculture system under the influence of a very small township of Nagina, which is not a census town, and is lying within a radius of 2 kilometers from the village. Sewka was selected in order to study the locational pattern of cropping in a condition where 87% net sown area is under tube-well irrigation. Balola was selected in order to study the location of crops solely in a system of rainfed agriculture. Iqbalpur village is taken up for studying the influence of improved accessibility on account of nearness to a road, since the impact of both railway and road on the cropping patterns of an individual village would not be much different, therefore, village Iqbalpur was taken as the representative village for studying the impact of accessibility. Karamchandpur is selected to study the influence of canal/canal irrigation on the location of crops. Silokhra is selected for studying the influence of big cities like Gurgaon/Delhi in an irrigation propelled agricultural system.

The territory of each sample village is divided into six zones of almost equal width. These zones are drawn in the form of concentric arcs from the core of the village habitat. The area of each zone was computed taking into account the number of squares of a graph paper placed on the village map falling in each concentric zone. On the same lines, distribution of various crops/crop groups for both Rabi and Kharif cropping seasons was worked out separately for each zone ranging from Zone-1 to Zone-VI (Appendix-XI). The percentages of the area of each crop/crop groups under consideration was worked out by putting the total area of each zone in the denominator. The zone-wise acreage under each crop/crop groups in the form of percentages was plotted as a simple line graph along ordinate and the average distance of each zone width from the village settlement along abscissa. A scatter plot together with a trend line the line of best fit based on least square method was drawn for the purpose of interpertation of the results. A bivariate correlation and regression coefficient was computed by taking distance from the village as an independent variable and the individual crop/crop group acreage in percentage as dependent variable. The t-test helped in testing of hypothesis which the coefficient of determination explained in terms of the role of the variable in the spatial variation location of crops. This provided a better understanding about the degree as well as direction of correlation for the pairs of variables under consideration (Appendix-XII). A detailed analysis of individual villages is preesnted below.

VILLAGE GUMAT BIHARI

With a total area of 312 hectares, and a population of 671 persons (Census of India, 1991), the village is situated in Nagina block of the district of Gurgaon. Out of 312 hectares, 113 hectares of land is classified as wasteland and the other 6 hectares as uncultivable land. During the agricultural calender year of 1993-94, 249 hectares of land was put to agriculture as gross cropped area collectively both in Kharif and Rabi cropping seasons, with only 193 hectares as net sown area. Hence, the intensity of cropping is worked out to be 29.02%.

The village mostly rely upon rainfall for agriculture. On account of saline underground water condition prevailing in most of the village area, only 8.3% of the net sown area is irrigated by tube-wells. The rest of the net sown area (91.7 %) heavily depends upon rainfall for agriculture, both in Kharif and Rabi cropping seasons.

The village Gumat Bihari, about 90 kilometers from Delhi, is situated at a distance of 16 kilometers from Nuh-the nearest census town to the village. However, Nagina settlement which is not recognised as an urban settlement (Census of India, 1991) is lying within two kilometers from the village. It acts as a potential market place for agricultural produce from the surrounding area. The village is more than 2 kilometers away from any of the canal as well as any of the state highway/railway. Delhi-Alwar State Highway No.13 is more than 5 kilometers from this village. Hence, village Gumat Bihari provides an example to study the locational patterns of cropping with increasing distance from the village settlement under the influence of a small market place Nagina, within the constraints of rainfed agriculture with no or negligible influences of canals and transportation arteries.

The territory of the village is divided into six concentric zones of equal width of 250 meters originating from the centre of the village settlement for the purpose of this study. In this village, during the Kharif cropping season cultivation of fodder crops and pulses was not practised during 1993-94 agricultural calender year. Hence, the study of locational patterns of crops/crop groups for Kharif (Fig. 7.1a) and Rabi (Fig. 7.b) cropping seasons and cropping intensity with respect to the increasing distance from the village settlement is taken up. The following inferences are drawn from the study.

(a) Cropping intensity and distance from the village settlement

The study of the Fig.7.1.1A reveals that there is a general declining trend in cropping intensity as the distance from the village settlement increases. However, there is a slight increase in the intensity of cropping in Zone-II (5.2%) as compared to Zone-I (4.1%). The scatter plot (Fig 7.1.1B) also exhibits the declining trend of cropping intensity with increasing distance from the village settlement. A very strong negative correlation of - 0.9244 with a negative regression coefficient of -0.00392 further strengthens the above statement.

Moreover, the coefficient of determination of 0.8545 indicates that 85.45% of spatial variation in the cropping intensity is explained alone by distance from the village settlement. The t-statistic of 4.8471 of the regression coefficient with 4 degrees of freedom shows that regression coefficient is significant at

VILLAGE GUMAT BIHARI
DISTRIBUTION OF CROPS
KHARIF CROPPING SEASON
1993-94

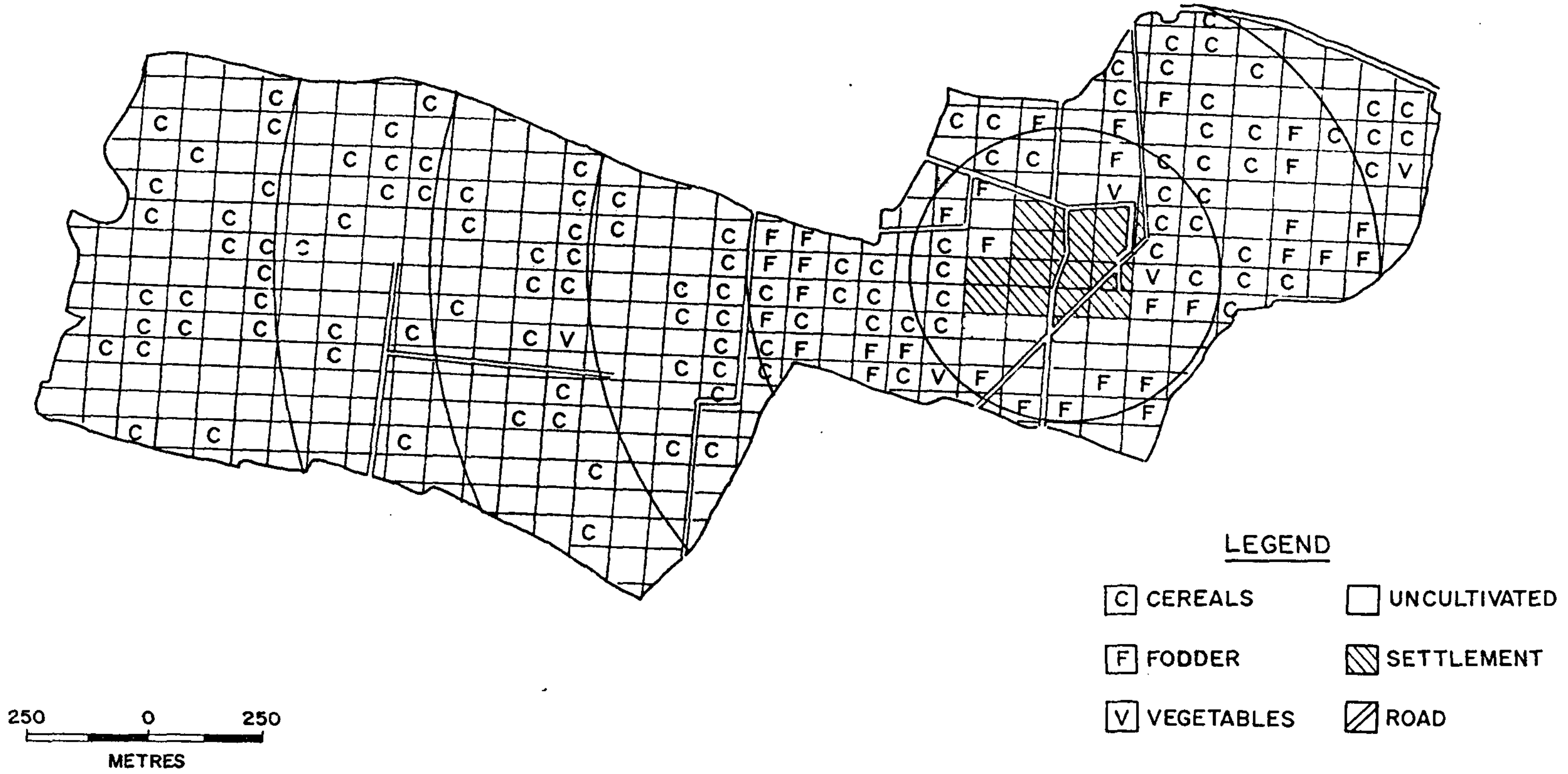


Fig.7.1a

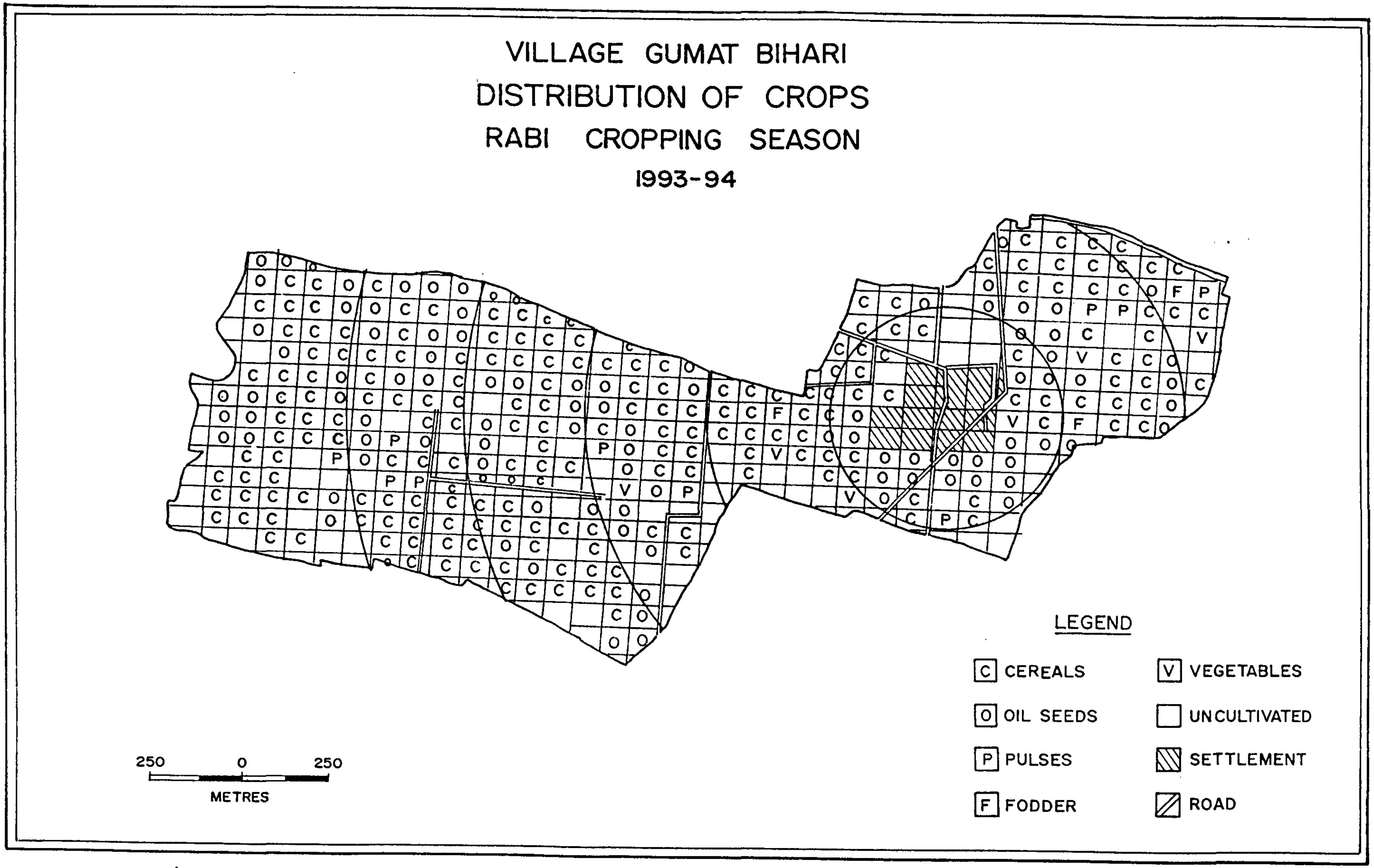

VILLAGE GUMAT BIHARI
DISTRIBUTION OF CROPS
RABI CROPPING SEASON
1993-94
LEGEND
C CEREALS
O OIL SEEDS
P PULSES
F FODDER
V VEGETABLES
UNCULTIVATED
SETTLEMENT
ROAD
250 0 250
METRES

Fig.7.1b

less than 0.01 level of significance. It means that the proportionate decrease in the cropping intensity is real and is not due to chance.

In this convincing confirmation of the hypothesis, no overt economic consideration is involved. In fact, the location of tube-wells, and quality of soils, the fertility of which generally decreases away from the village habitat are the most important factors generating this pattern of cropping intensity. Hence, the hypothesis that intensity of cropping decreases with increasing distance from the village settlement holds true.

(b) Area under crops/crop groups and distance from the village settlement

(i) Cereals (Kharif) - In Gumat Bihari only two Kharif cereal crops were grown during 1993-94. These crops are Bajra and Jowar. Bajra accounts for about 94.4% while Jowar accounts for about 5.6% of the total area under Kharif cereals. The area under cereals of Kharif cropping season shows a declining trend (Fig.7.1.2A) with respect to increasing distance from the village settlement. However, there is a slight increase in the percentage of the area under cereals in Zone-VI (30.8%) as compared to Zone-V (23.3%). The scatter plot (Fig.7.1.2B) with least square line also confirms the statement of general declining trend in the distribution of Kharif cereals with increasing distance from the village settlement. A strong negative correlation of -0.7824 with a negative regression coefficient of -0.0124 further strengthens the above mentioned statement.

Moreover, the coefficient of determination of 0.6122 indicates that 61.22% of the spatial variation in the distribution of .Kharif cereals is explained by distance from the village settlement. The t-statistic of 2.51295 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It means that the proportionate decrease in the distribution of Kharif cereals is real and is not due to chance.

Hence, the hypothesis that area under cereal crops increases with increasing distance from the village settlement stands rejected in the case of Gumat Bihari. It is perhaps extra brackish underground water in other parts of the village which is unsuitable for irrigation that explains the declining trend of locational distribution of Kharif cereals.

(ii) **Cereals (Rabi)** - During Rabi cropping season only three cereal crops were grown. Among these crops, wheat occupied largest area, about 92% under Rabi cereals. Wheat was followed by barley (about 7.0%) and gram (about 1%) of the total area put to Rabi cereals.

The zone-wise total area under Rabi cereals represents a confusing picture. No clear perceptible trend with increasing distance from the settlement of the village is found (Fig.7.1.2A). It increases to 64.4% in Zone-II as compared to 47.2% in Zone-I. In Zone-III it declines to 51.7% and rises again in Zone-IV and Zone-V to 57.4% and 66.7%, respectively. In Zone-VI it declines sharply to

44.9%. The scatter plot (Fig.7.1.7B) with least square line also confirms the above statement. The line of best fit is almost parallel to abscissa. A very weak positive correlation coefficient of 0.0065 with a very small regression coeffecient of 0.00013 further strengthens the above mentioned statement.

Moreover, the coeffecient of determination of 0.0043 indicates that only 0.43% of the spatial variation in the distribution of Rabi cercals is explained by distance from the village settlement. The t-statistic of 0.01308 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It means that the proportionate increase in the distribution of Rabi cereals is not real and is due to chance.

Hence, the hypothesis that area under cereal crops increases with increasing distance from the village settlement stands unacceptable. Under dry conditions and little irrigation facilities high yielding varieties of wheat which require at least four waters in semi-arid climate of the village are discouraged to be grown over vast areas even in the form of extensive agriculture. This factor explains why the concentration of Rabi cereals decline with increasing distance from the village settlement in Gumat Bihari.

(iii) Vegetables (Kharif) - The area under vegetables during Kharif cropping season shows a declining trend (Fig.7.1.1A) with respect to increasing distance from the village settlement. However, the graph shows two peaks in its trend. One is at Zone-III, where it increases to 1.7% as compared to 1.1% in Zone-II. The other peak is at Zone-V, where the percentage of area put to vegetables again rises to 1.7% as compared to 0.0% in Zone-IV. The scatter plot (Fig.7.1.3B) with the line of best fit exhibits a general decline in the percentage of area put to the cultivation of vegetables during Kharif cropping season. A strong negative correlation of -0.7162 with a negative regression coefficient of -0.00216 further strengthens the above statement.

Moreover, the coefficient of determination of 0.5129 indicates that 51.29% of spatial variation in the distribution of Kharif vegetables alone is explained by distance from the village settlement. The t-statistic of 2.0525 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It means that the proportionate decrease in the distribution of Kharif vegetables is real and is not due to chance.

In this convincing confirmation of the hypothesis, no overt economic consideration is involved. In fact, the location of tube-wells, and quality of soils, the fertility of which generally decreases away from the village habitat are the most important factors generating this pattern of vegetables distribution.

Hence, the hypothesis that area under vegetables decreases with increasing distance from the village settlement is accepted. The maximum area under vegetables at the nearby location of village settlement explains the need of requisite frequent visits to the fields by farmers for reasons of safety, and much labour input.

(iv) **Vegetables (Rabi)** - The cultivated area put to vegetables during Rabi cropping season shows a steep decline (Fig.7.1.4A) with respect to increasing distance from the village settlement. However, the graph shows an increase in the percentage of area put to the cultivation of vegetables in Zone-II (3.4%) as compared to Zone-II (2.2%). The scatter plot (Fig.7.1.8B) with the line of best fit also presents a general decline in the percentage of area under the cultivation of vegetables during the Rabi cropping season. A very strong negative correlation of -0.9059 along with a negative regression coefficient of -0.00423 futher supports the above statement.

Moreover, the coefficient of determination of 0.8206 indicates that 82.06% of spatial variation in the distribution of vegetables of Rabi cropping season is explained alone by distance from the village settlement. The t-statistic of 4.2772 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at even less than 0.01 level of significance. It means that the proportionate decrease in the distribution of Rabi vegetables is real and is not due to chance.

This confirms the hypothesis that distance is a major factor in determining the location of vegetables with respect to the village settlement. Apart from the quality of soil and location of tube-wells, the protection of fields from stray animals is also a factor in decision making for cultivation of vegetables.

Hence, the hypothesis that area under vegetables decreases with increasing distance from the village settlement is acceptable.

Since there is no irrigation in this village, the influence of village settlement on the location of vegetable cultivation is profound.

(v) **Fodder (Kharif)** - The area under fodder crops during Kharif cropping season shows a steady decline (Fig.7.1.2A) with increasing distance from the village settlement. In Zone-1 it occupies 28.3% of the cultivated area while in Zone-VI, the area under fodder is zero precent. The scatter plot (Fig.7.1.5B) with line of best fit also confirms the same trend of fodder distribution, A very strong negative correlation of -0.939506 along with a regression coefficient of -0.02389 also ensures that with increasing distance from the village settlement there is a definite decline in the area occupied by fodder crops.

Moreover, the coefficient of determination of 0.8827 indicates that 88.27% of the spatial variation in the distribution of Kharif fodder is explained alone by distance from the village settlement. The t-statistic of 5.4856 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at even less than 0.01 level of significance. It means that the proportionate decrease in the distribution of Kharif fodder is very much real and is not due to chance.

Hence, the hypothesis that area under fodder crops would increase with increasing distance from the village settlement is not acceptable in the case of Gumat Bihari. It is, therefore, inferred that under uniform condition of water supply, the influence of village settlement on the location of crops particularly those crops which are of low value and heavy bulk, like fodder is significantly high. Moreover, during Kharif cropping season when maximum amount of ranifall is obtained through south-west monsoons, crops like fodder and vegetables are greatly influenced by the factor of distance from the village settlement. Moreover, the area occupied by fodder crops in every zone from the village settlement ranks second after cereals. It shows that economic considerations are involved and being a rainfed agricultural economy of Gumat Bihari, farmers seem to be more inclined towards the commercial dairy farming. That is why fodder is the next choice of the farmers after cereals. In fact the cultivation of fodder is not extensive, rather it is intensive and caters to demand of fodder in the village. Being a bulky product, farmers grow it near the village settlement for ease of transportation.

(vi) **Fodder (Rabi)** - The area under fodder crops of Rabi cropping season does not show any remarkable trend (Fig.7.1.4A). In Zone-I the percentage of area under fodder is zero, in Zone-II, Zone-III the respective figures are 2.2% and 1.7% respectively. In Zone-IV the area under fodder is culminated into zero percent. In Zone-V it increases to 1.7% to be declined again to zero percent in Zone-VI.

This situation is explained more clearly by the scatter plot (Fig.7.1.10B) and a weak negative correlation of - 0.1647 along with a negative regression coefficient of - 0.00037.

Moreover, the coefficient of determination of 0.0271 indicates that only 2.71% of the spatial variation in the distribution of Rabi fodder is explained by distance from the village settlement. The t-statistic of 0.3339 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It means that there is no relationship between area under Rabi fodder and distance from the village settlement and whatever relationship is observed is due to chance.

Hence, the hypothesis that area under fodder crops would increase with increasing distance from the village settlement is nullified for the reason cited above in case of Kharif fodder.

(vii) **Oil Seeds (Rabi)** - The area under oil seeds of Rabi cropping season shows a general declining trend (Fig.7.1.3A) with increasing distance from the village settlement. However, in Zone-IV there is a rise (29.4%) in the area under oil seeds as compared to that of Zone-III (20.7%). The scatter plot with least square line (Fig.7.1.9B) also confirms that there is a decline in the area under oil seeds with increasing distance from the village settlement. A negative correlation of - 0.6309 along with a regression coefficient of - 0.02389 also explain that with increasing distance from the village settlement the area under oil seeds decreases.

However, the coefficient of determination of 0.398 indicates that 39.80% of the spatial variation in the distribution of Rabi oil seeds is explained by distance from the village settlement. The t-statistic of 1.6261 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at more than 0.05 level of significance. This indicates that whatever moderate relationship between the two is observed is not significant and is the result of chance in sampling.

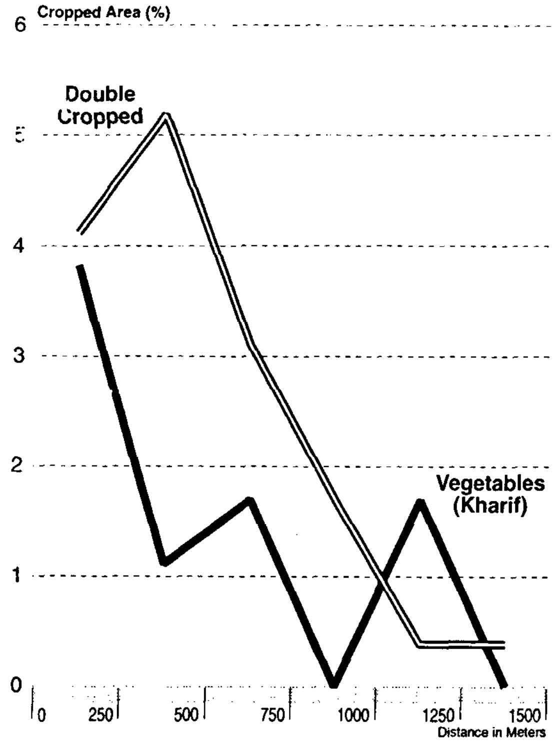
Hence, the hypothesis that area under oil seeds would increase with increasing distance from the village settlement stands unaccepted. This situation in the case of Gumat Bihari reveals that under the acute shortage of water supply even those crops which can otherwise be grown extensively on marginal land are not affected by the geometry of economic rent generated by a number of economic consideration.

(viii) Pulses (Rabi) - The area under pulses of Rabi cropping season describes no definite trend with respect to distance from the village settlement (Fig.7.1.4A). Marked fluctuations in the percentage of area occupied by pulses from Zone-I to Zone-VI are the important features of the distribution of pulses. The scatter plot (Fig.7.1.11B) also reveals the same trend of distribution. A weak negative correlation of -0.4139 along with a regression coefficient of -0.0165 also makes it clear that there exists no significant relationship between the area under pulses and distance from the village settlement.

Further, the coefficient of determination of 0.1713 indicates that only 17.13% of the spatial variation in the distribution of Rabi pulses is explained by distance from the village settlement. The t-statistic of 0.9093 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant

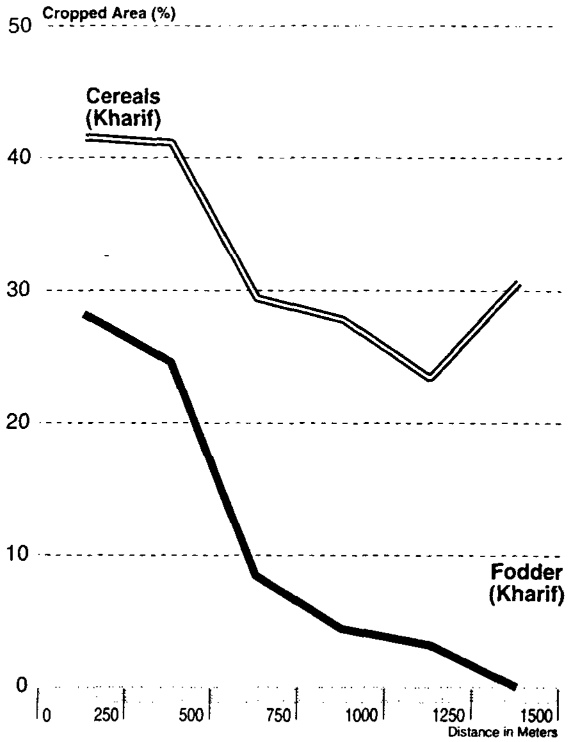
Village Gumat Bihari **1A**

Distribution of Crops/Cropping Intensity
Nagina (Gurgaon)
1993-94



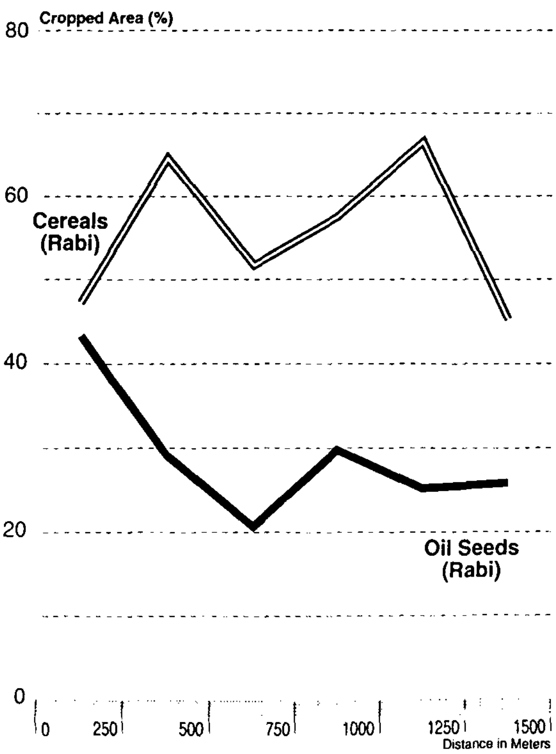
Village Gumat Bihari **2A**

Distribution of Crops/Cropping Intensity
Nagina (Gurgaon)
1993-94



Village Gumat Bihari **3A**

Distribution of Crops/Cropping Intensity
Nagina (Gurgaon)
1993-94



Village Gumat Bihari **4A**

Distribution of Crops/Cropping Intensity
Nagina (Gurgaon)
1993-94

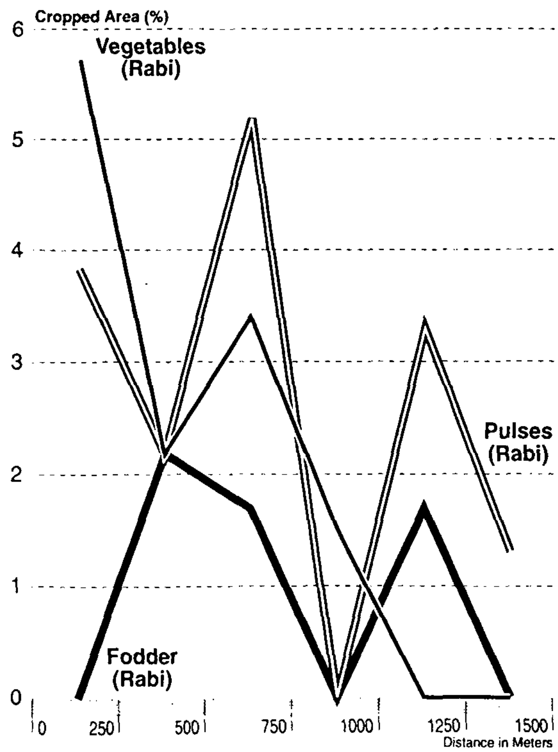


Fig. 7.1

Village Gumat Bihari

Locational Patterns of Cropping

(1993-94)

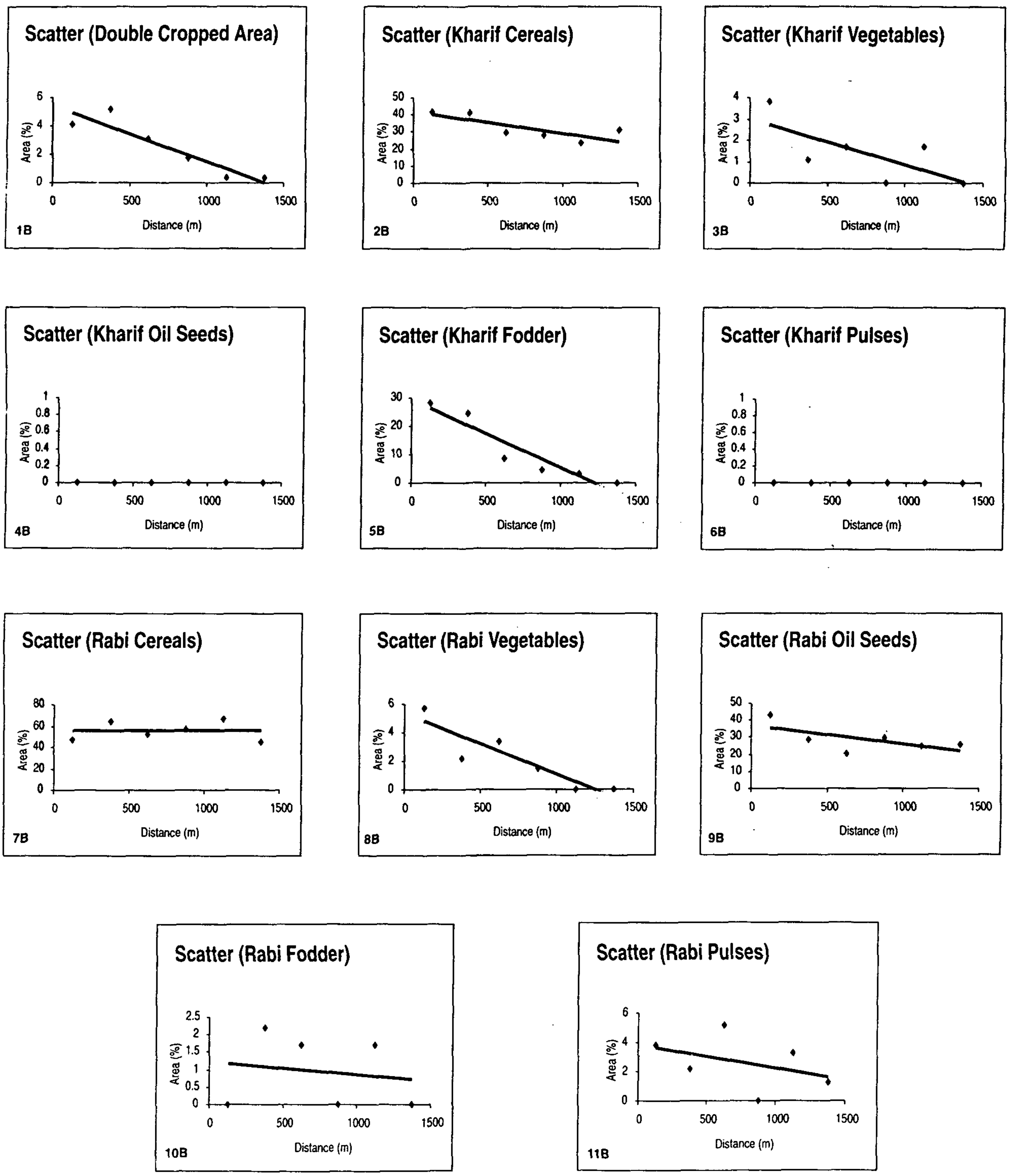


Fig. 7.1

at even more than 0.05 level of significance. It means that the proportionate decrease in the distribution of Rabi pulses is not real and whatever the relationship is observed is due to chance.

Hence, the hypothesis that area under pulses would increase with increasing distance from the village settlement stands rejected. Unlike Kharif pulses, the pulses of Rabi cropping season show that the trend of their apparent distribution though statistically is not proved true, yet it is significant in a scense that it occupies prime land near-by the village settlement. It shows that Rabi pulses in Gumat Bihari are grown for commercial purpose.

Concluding the findings obtained in the case of Gumat Bihari it may be stated that under the strained rainfed agriculture and the influence of a small township, the hypotheses formulated came true only in resepect of intensity of cropping, vegetables of both Rabi and Kharif cropping season, and Kharif fodder. The other crops/crop groups could not validate their respective hypotheses.

VILLAGE SEWKA

The total area of the village Sewka is 140 hectares and the population of the village comprises 663 inhabitants (Census of India, 1991). The village is situated in Taoru block of the district of Gurgaon. Out of 140 hectares, 13 hectare of land is classified as uncultivable land and the other one hectare as waste land. During the agricultural calender year 1993-94, 194 hectares of land was put to cropping as gross cropped area combinedly in Kharif and Rabi cropping seasons, with only 126 hectares of land as net sown area. So the intensity of cropping was worked out to be 53.97% for the year 1993-94.

The village heavily depends upon tube-well irrigation for agriculture. More than 87% of the net sown area is irrigated by tube-wells. The rest of the cultivated area is rainfall dependent. The dependency on irrigation for cropping is more during Rabi than Kharif cropping season.

The village Sewka is situated about 5 kilometers from the township of Taoru, which is the nearest urban settlement to the village. The village is also situated at a distance of more than 2 kilometers away from any state highway/railway and any canal of the study area. Hence, village Sewka presents an ideal situation where variation in cropping pattern with respect to tube-well irrigation in the absence of influence exerted by road /railway, canals and cities can be analysed in a systematic manner. The territory of the village is divided into six concentric zones of equal width of 250 meters with respect to the centre of the village settlement for the purpose of study.

In this village during the Kharif cropping season cultivation of pulses was not practiced in the agricultural calender year of 1993-94. Hence, the study of the locational patterns of rest of the crops/crop groups of Kharif cropping season (Fig. 7.2a) and Rabi cropping season (Fig. 7.2b) and cropping intensity with respect to increasing distance from the village settlement is taken up. The following inferences are drawn from this study.

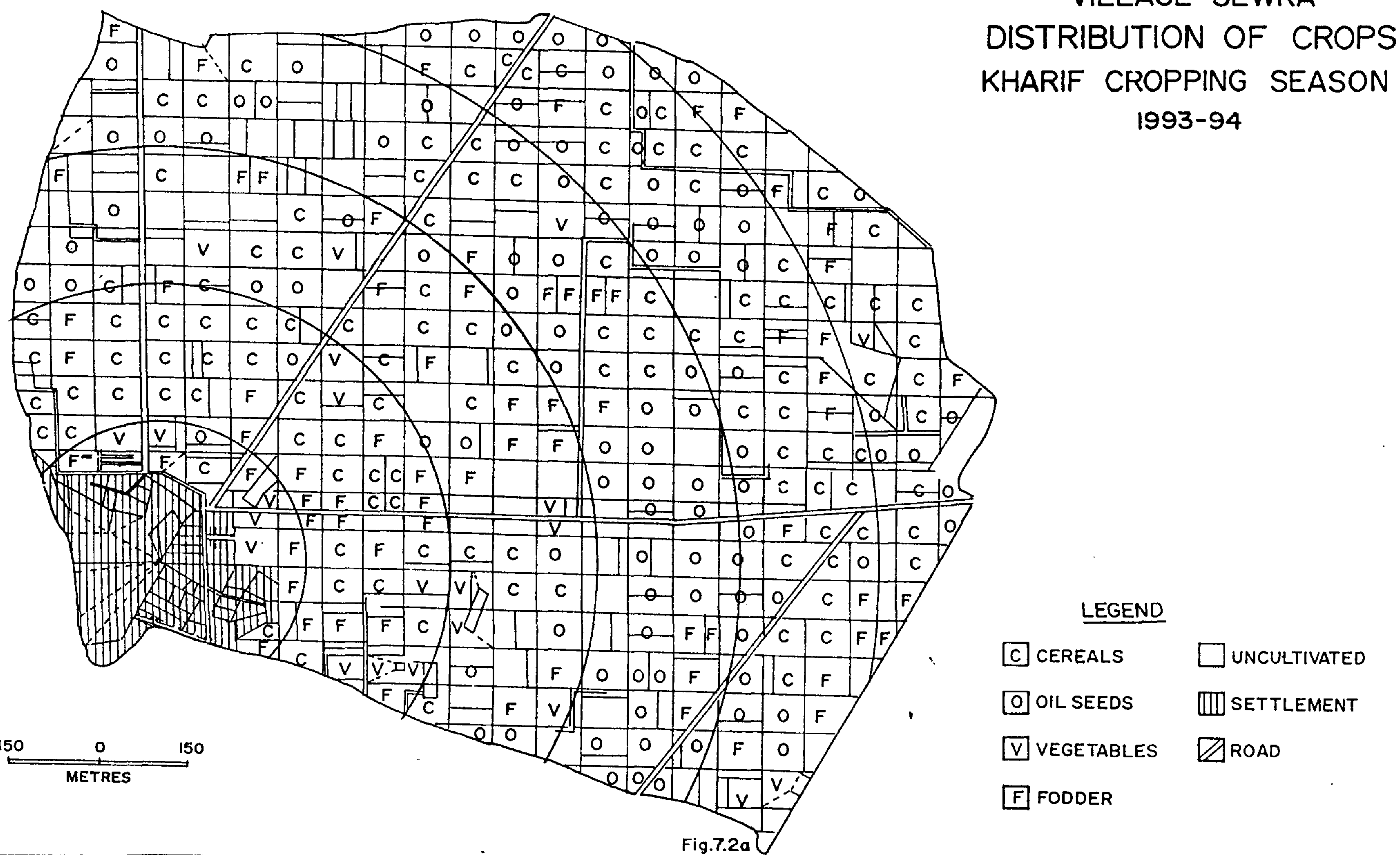
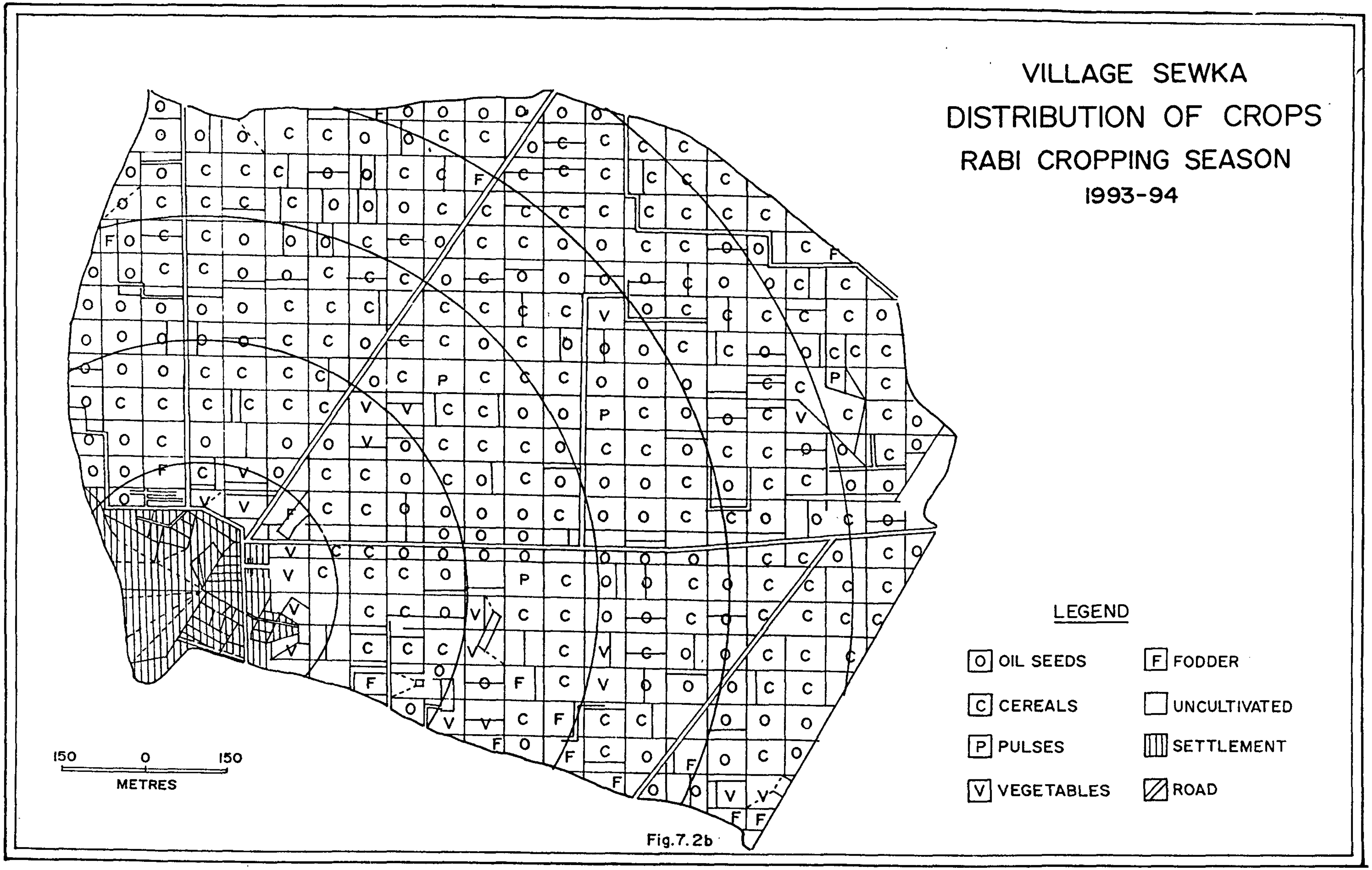

VILLAGE SEWKA
DISTRIBUTION OF CROPS
KHARIF CROPPING SEASON
1993-94
LEGEND
C CEREALS
O OIL SEEDS
V VEGETABLES
F FODDER
UNCULTIVATED
SETTLEMENT
ROAD
150 0 150
METRES

Fig.7.2a



VILLAGE SEWKA
DISTRIBUTION OF CROPS
RABI CROPPING SEASON
1993-94
LEGEND
O OIL SEEDS
C CEREALS
P PULSES
V VEGETABLES
F FODDER
UNCULTIVATED
SETTLEMENT
ROAD
150 0 150
METRES

Fig.7.2b

(a) Cropping intensity and distance from the village settlement

The examination of graph (Fig. 7.2.1A) reveals the fact that there exists no relationship between the cropping intensity and the distance from the village settlement. The cropping intensity increases from 4.1% in Zone-I to 8.2% in Zone-II and to 10.3% in Zone-III. From Zone-III onward the intensity of cropping is observed to decline to 8.0% in Zone-IV, 6.4% in Zone-V and 5.4% in Zone-VI. The scatter plot (Fig.7.2.1B) depicts the same situation represented by the line of best fit which lies almost parallel to abscissa. A weak negative correlation of -0.028898 along with a negative regression coefficient of - 0.000137 further emphasise that there exists almost no relationship between the cropping intensity and distance from the village settlement. The coefficient of determination of 0.00084 indicates that 0.084% of the spatial variation in the cropping intensity is explained by distance from the village settlement. The t-statistic of 0.0578 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It means that there is no relationship between cropping intensity and distance from the village settlement.

Hence, the hypothesis that cropping intensity decreases with increasing distance from the village settlement does not hold good in the case of village Sewka. It is perhaps on account of uniform irrigation facilities present in this village. More than 87% of the net sown area is irrigated by tube-wells which facilitated even the distant fields to be sown repeatedly in a year negating the influence of distance from the village settlement.

(b) Area under crops/crop groups and distance from the village settlement

(i) Cereals (Kharif) - In Sewka village three cereal crops were cultivated during the Kharif cropping season of 1993-94. These crops are Bajra, Jowar and paddy. Bajra alone accounts for about 83% of the total area put under cereal crops, while Jowar and paddy account for about 12% and 5% of the area respectively.

The total area under cereal crops of Kharif cropping season (Fig.7.2.2A) represents a general increasing trend with distance from the village settlement. However, in Zone-III the area under cereals declines (21.4%) as compared to Zone-II (36.4%). From Zone-III onward, there is a continuously rising trend upto Zone-VI. The scatter plot (Fig.7.2.2B) with least square line also shows the same general rising trend of the distribution of cereals with increasing distance from the village settlement. A strong positive correlation of 0.7549 with a positive regression coefficient of 0.02546 further confirms the above mentioned statement. The coefficient of determination is worked out as 0.5698 which indicates that 56.98% of the locational variation in the distribution of Kharif cereals is explained by distance from the village settlement. The t-statistic of 2.3019 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It means that the proportionate increase in the area under Kharif cereals is genuine and is not due to chance. As a matter of fact, this confirmation of the hypothesis, is the result of better and assured irrigation through tube-wells even in the event of monsoon failure, which has generated this pattern of the location of cereals.

Hence, the hypothesis that area under cereal crops increases with increasing distance from the village settlement holds good and is accepted in the case of village Sewka.

(ii) **Cereals (Rabi)** - During the Rabi cropping season of 1993-94 in this village only two cereal crops were grown. Wheat which sweeped 97% of the total area put to the cultivation of cereal crops emerged as the single largest cereal crop of Rabi season. The other crop, gram occupied only 3% of the area.

The total area under cereal crops during Rabi season represents a definite increasing trend with respect to increasing distance from the village settlement (Fig.7.2.3A). However, there is a little decline in the percentage figures of the area under cereal crops in Zone-III and Zone-IV. In Zone-III it has declined to 40% from 45.5% of Zone-II, while in Zone-IV it has further declined to 37%. The scatter plot with the line of best fit (Fig.7.2.7B) exhibits a general increasing trend of the percentage of area put to the cultivation of cereals during Rabi cropping season. A very strong positive correlation of 0.8594 along with a positive regression coefficient of 0.03343 further supports the above mentioned statement.

Moreover, the coefficient of determination of 0.7386 indicates that 73.86% of the spatial variation in the distribution of Rabi cereal is explained by distance from the village settlement. The t-statistic of 3.3622 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It means that the proportionate increase in the distribution of Rabi cereals is real and is not due to chance.

In this convincing confirmation of the hypothesis, it can be argued that assured irrigation by tube-wells provides a guarantee for successful cultivation of high yielding varieties of wheat, the grain which holds a share of 97% among the Rabi cereals is also the first choice of farmers during Rabi cropping season. These two facts play vital role in determining the present location of cereals across the agricultural landscape of the village Sewka during Rabi cropping season.

(iii) **Vegetables (Kharif)** - The area put to the cultivation of vegetables during Kharif cropping season (Fig.7.2.1A) shows a steady declining trend with only one exception in Zone-V where it slightly increases to 2.7%, and in Zone-VI where it has increased to 2.9% as compared to Zone-III where the percentage of area is 1.1 under vegetables. The scatter plot (Fig.7.2.3B) with line of best fit also exhibits a steep declining trend from Zone-I to Zone-VI in the percentage of area under cultivation of vegetabels. This graphic representation is strongly supported by a negative correlation of -0.8258 along with a negative regression coefficient of -0.01961. Moreover, the coefficient of determination of 0.6820 indicates that 68.20% of the spatial variation in the distribution of Kharif vegetables is explained by distance from the village settlement. The t-statistic of 2.9288 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It means that decrease in the area under vegetables of Kharif with distance from the village settlement is real and is not due to chance.

Hence, the hypothesis that area under vegetables decreases with increasing distance from the village settlement is accepted. Since assured water supply for the cultivation of vegetables is there either in the form of uniform irrigation or summer rains during Kharif cropping season, the impact of distance from the village settlement is observed. A very high percentage of area under, vegetables cultivation 30.8% in Zone-I, 10.9% in Zone-II and 8.6% in Zone-III explains that a ready market for vegetables is there.

(iv) **Vegetables (Rabi)** - In village Sewka the area put to the cultivation of vegetables during Rabi cropping season shows a steep declining trend (Fig.7.2.4A) right from Zone-I to Zone-VI except in Zone-III (7.1%) where a slight increase in the area under vegetables is observed as compared to Zone-II (5.5%). The scatter plot (Fig.7.2.8B) with the line of best fit also represents a steep declining trend in the distribution of vegetables with increasing distance from the village settlement. This graphical representation is strongly supported by a negative correlation of-0.7242 and a negative regression coefficient of -0.03158. Moreover, the coefficient of determination of 0.5244 indicates that 52.44% of the spatial variation in the distribution of Rabi vegetables is explained by distance from the village settlement. The t-statistic of 2.1003 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It means that decrease in the area under Rabi vegetables with increasing distance from the settlement is genuine and conforms well with the hypothesis under postulates of the Von Thunen's theory.

An assured tube-well irrigation, vicinity of Taoru township are the two favourable factors in Sewka which are operating simultaneously as far as cultivation of vegetables at a large scale is concerned. In Zone-I vegetables occupy 53.8% area and rank first. Since vegetable fields also require frequent vistis of the farmers/cultivators, therefore, being a labour intensive crop, they hold a location near the habitat of the village. Hence, the hypothesis that area under vegetables decreases with increasing distance from the village settlement is accepted.

(v) **Oil Seeds (Kharif)** - The line graph of oil seed distribution (Fig.7.2.2A) for Kharif cropping season exhibits no definite trend of distribution. It rises upto Zone-III and drops after wards upto Zone-VI. The scatter plot (Fig.7.2.4B) and the line of best fit is showing a slight increase in the distribution of oil seeds with increasing distance from the village settlement. However, a weak positive correlation of 0.32542 and a regression coefficient of 0.01374 point out that the rising trend as depicted by the line of best fit is not statistically significant. As the coefficient of determination of 0.1059 indicates that 10.59% of the spatial variation in the distribution of Kharif oil seeds is explained by distance from the village settlement. The t-statistic of 0.6883 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at less than 0.05 level of significance. Thus, statistically the increasing trend in the area under oil seeds with increasing distance from the settlement is not confirmed and whatever a small relationship is observed, is mainly due to chance in sampling. On account of low demand and small concentrations, Til, the only Kharif oil seed crop suffers a great deal of subjectivity and farmers' biasness in defining its locational distribution in the village.

Hence, the hypothesis that area under oil seeds would increase with increasing distance from the village settlement is not accepted.

(vi) **Oil seeds (Rabi)** - An examination of zone-wise distribution of oil seeds of Rabi cropping season (Fig.7.2.3A) reveals that there is no definite trend of distribution of this crop group in village Sewka. The area put to the cultivation of oil seeds increases from Zone-I to Zone-IV and thereafter, it starts to decrease up to Zone-VI. The scatter plot (Fig.7.2.9B) with the line of best fit also reveals the same trend of distribution of oil seeds. A very weak positive correlation of 0.07957 and a regression coefficient of

0.00026 do not confirm a real increase in area under Rabi oil seeds with distance from the settlement.

It is further highlighted by a small coefficient of determination of 0.00633 which points out that only 0.633% of the spatial variation in the distribution of Rabi oil seeds is explained by distance from the village settlement. The t-statistic of 0.15965 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at more than 0.05 level of significance. It implies that like Kharif oil seeds locational pattern of Rabi oil seeds has no bearing on distance with respect to village settlement.

Hence, the hypothesis that area under oil seeds increases with increasing distance from the village settlement does not hold good in the case of village Sewka.

(vii) **Fodder (Kharif)** - The line graph showing the distribution of fodder crops of Kharif cropping season (Fig.7.2.1A) shows a continous declining trend upto Zone-IV, there after it increases to 12.0% and 23.5% in Zone-V and VI respectively. The scatter plot with the line of best fit (Fig.7.2.5B) also shows a continuously declining trend of the distribution of fodder with increasing distance from the village settlement. A moderate negative correlation -0.62736 with a negative regression coefficient of -0.01911 supports the fact presented by the line of best fit. However, the coefficient of determination of 0.3936 indicates that only 39.36% of the spatial variation in the distribution of

Kharif fodder is explained by distance from the village settlement. Further t-statistic of 1.61123 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at more than 0.05 level of significance. It suggests that the apparent decrease in the distribution of Kharif fodder with distance from the village settlement is not validated by the statistical analysis.

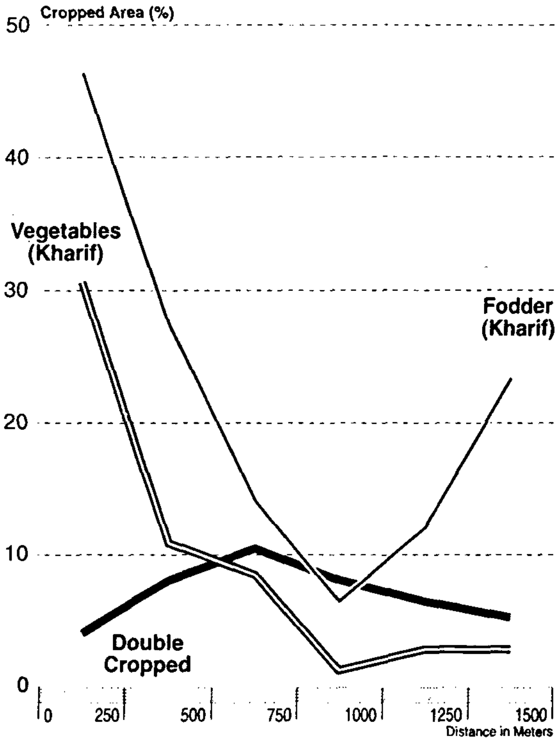
Hence, the hypothesis that with increasing distance from the village settlement the distribution of fodder would increase is not accepted. The distribution of fodder crops viz-a-viz other crops in respective zones is ranked as first in Zone-I, second in Zone II, third in Zones-III, V and VI, and fourth in Zone-IV. This intercrop ranking position of fodder points out the special inclination of farmers towards dairy farming. The milk and milk products find a good market potential in towns like Taoru (12,534 persons, at 5kms), Sohna (16,348 persons, at 26 kms) and Gurgaon (1,35,884 persons, at 49kms).

(viii) **Fodder (Rabi)** - The graphical record showing distribution of fodder during Rabi cropping season (Fig.7.2.4A) shows a continuous diclining trend with increasing distance from the village settlement. The scatter plot with the line of best fit (Fig.7.2.10B) also shows the same steep declining trend in the area under the cultivation of fodder with increasing distance from the village settlement. A strong negative correlation of -0.7151 and a negative regression coefficient of -0.00913 present a supporting evidence of the above observation. The coefficient of determination of 0.5122 indicates that 51.22% of the spatial variation in the distribution of Rabi fodder is explained by distance from the village settlement. The t-statistic of 2.04949 of the regression coefficient shows that the regression coefficient is significant at less than 0.05 level of significance. It implies that the proportionate decrease in the distribution of Rabi fodder is real and nullifies the hypothesis that distribution of fodder crops would increases with increasing distance from the village settlement. During Rabi cropping season the zone-wise area under fodder crops is not as high as in Kharif cropping season. This is partly because surplus fodder is grown during Kharif and comparatively more emphasis is placed on the cultivation of cereals and oil seeds during Rabi seasons.

(ix) **Pulses (Rabi)** - The line graph showing the distribution of pulses in Rabi cropping season (Fig.7.2.3A) depicts an irregular rising trend starting from Zone-III (2.8%), Zone-IV (1.1%) Zone-V (0.0%) to Zone-VI (2.9%). The scatter plot with the line of best fit (Fig.7.2.11B) though shows a rising trend is not supported by the statistics of correlation and regression. A weak positive correlation of 0.48987 and a positive regression coefficient of 0.00146 are unable to support the apparent rising trend of distribution of pulses as depicted by the scatter plot as the regerssion coefficient is not significant and its t-statistic is 1.1238 which means that even at more than 0.05 level of significance the regression coefficient is not different from zero. Further coefficient of determination suggests that only 24.00% variation in the locational pattern of Rabi pulses is explained by the factor of distance.

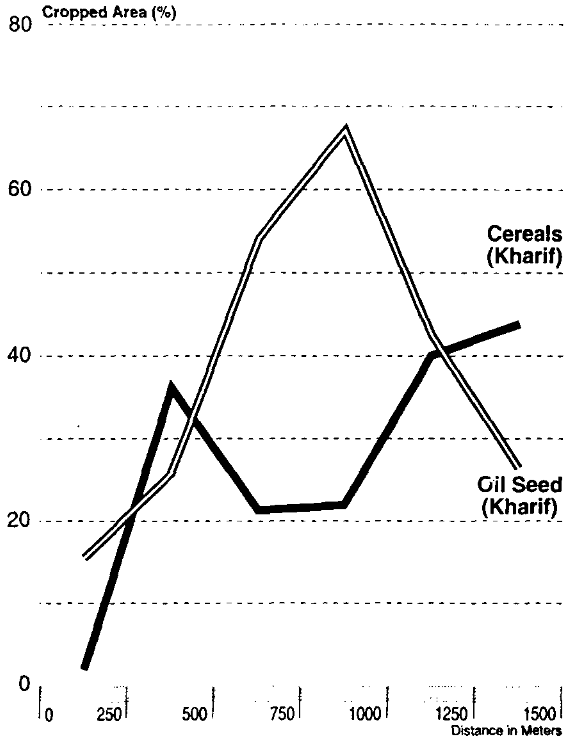
Village: Sewka **1A**

Distribution of Crops/Cropping Intensity
Taoru (Gurgaon)
1993-94



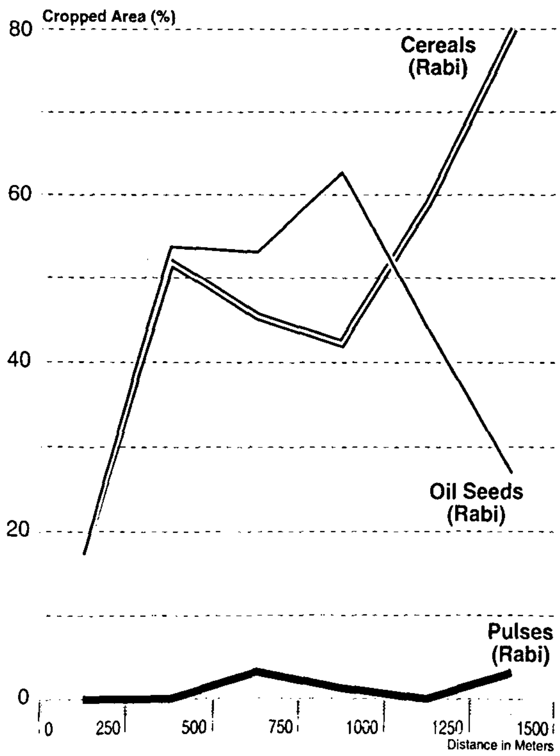
Village: Sewka **2A**

Distribution of Crops/Cropping Intensity
Taoru (Gurgaon)
1993-94



Village: Sewka **3A**

Distribution of Crops/Cropping Intensity
Taoru (Gurgaon)
1993-94



Village: Sewka **4A**

Distribution of Crops/Cropping Intensity
Taoru (Gurgaon)
1993-94

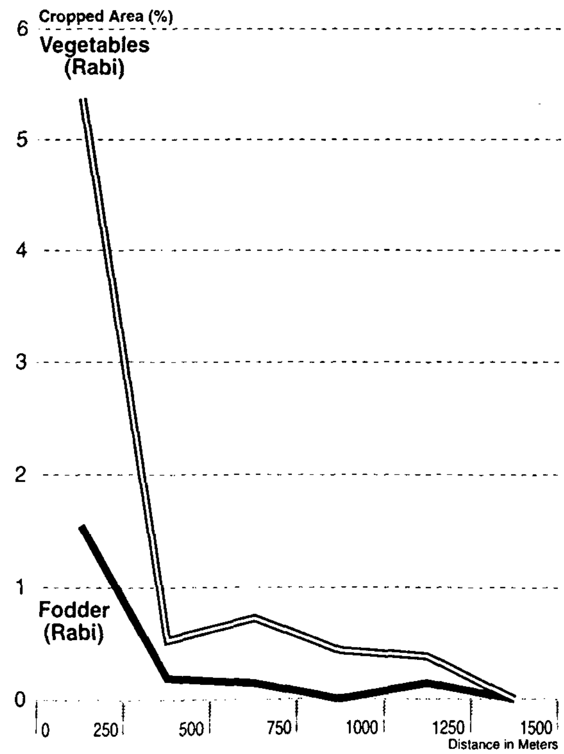


Fig. 7.2

Village Sewka

Locational Patterns of Cropping Around Village Settlements

(1993-94)

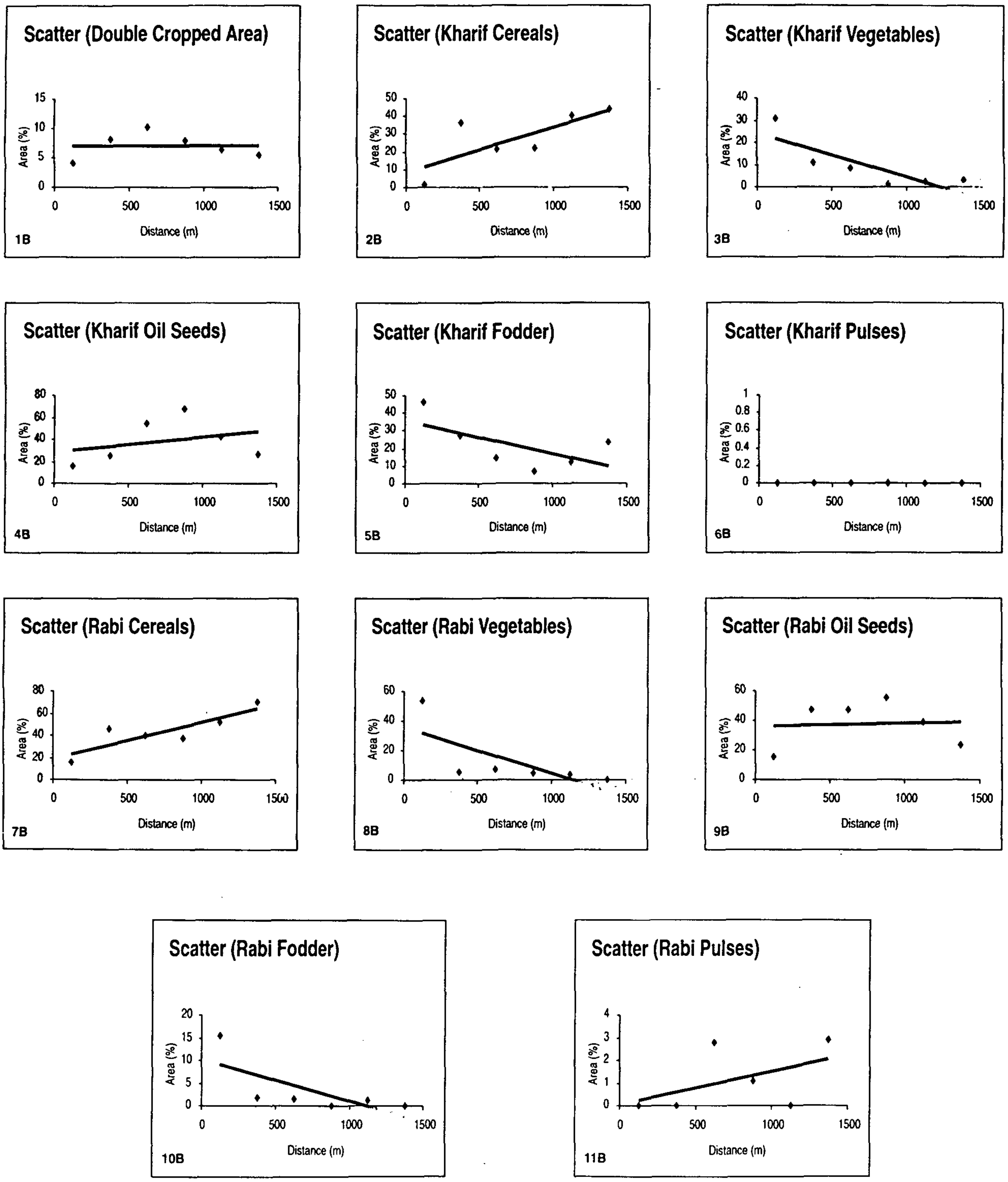


Fig. 7.2

It means that the hypothesis that area put to the cultivation of pulses would increase with increasing distance from the village settlement stands unaccepted. In Sewka neither during Kharif nor in Rabi much significance is placed on pulses. It shows that pulses are not a significant part of the village economy, and they are produced most probably for home consumption.

Concluding the findings of the village Sawka it may be stated that under the impact of tube-well irrigation the hypotheses formulated came true only in the case Rabi and Kharif cereals, vegetables, and fodder of only Rabi. The other crops/crop groups could not validate their respective hypotheses.

VILLAGE BALOLA

Balola with a geographical area of 628 hectares of land, and a population of 591 persons (Census of India, 1991) is situated in block Sohna of the district of Gurgaon. Out of 628 hectares, 83 hectares of land is classified as wasteland while another chunk of 140 hectares is designated as uncultivable land. During 1993-94 agricultural calander year, 475 hectares of land was put to cultivation as gross cropped area collectively for both cropping seasons of Kharif and Rabi.With a net sown area of 405 hectares, the percentage of double cropped area to net sown area was worked out to be 17.28% for the year 1993-94.

Balola lying in the hilly tract of the block Sohna, with 88.88% of its net sown area is dependent upon rainfall for cultivation. The remaining 11.12% of net sown area is irrigated by tube-wells. The dependency on rainfall for cropping is significantly high in both cropping seasons of Kharif and Rabi.

The village is situated more than 12 kilometres from Gurgaon city, and is about 9 kilometers from the state of Delhi. It is far away from any of the state highway/railway, or canal in the study area. Hence, the Village Balola provides a better opportunity to understand the locational pattern of cropping with an increasing distance from the village settlement under the strained conditions of rainfed agriculture only.

The territory of the village is divided into six zones in the from of six concentric circles/arcs of equal width of 400 meters drawn from the core of the village settlement.

In this village during the Kharif cropping season cultivation of oilseeds was not practiced during the agricultural calender year of 1993-94. Hence, the study of locational patterns of crops/crop groups of Kharif (Fig. 7.3a) and Rabi (7.3b) cropping seasons and cropping intensity with respect to increasing distance from the village settlement is taken up. The following inferences are drawn from this study.

(a) Cropping intensity and distance from the village settlement.

The analysis of the graph (Fig. 7.3.1A) reveals fact that there exists a strong negative relationship between the cropping

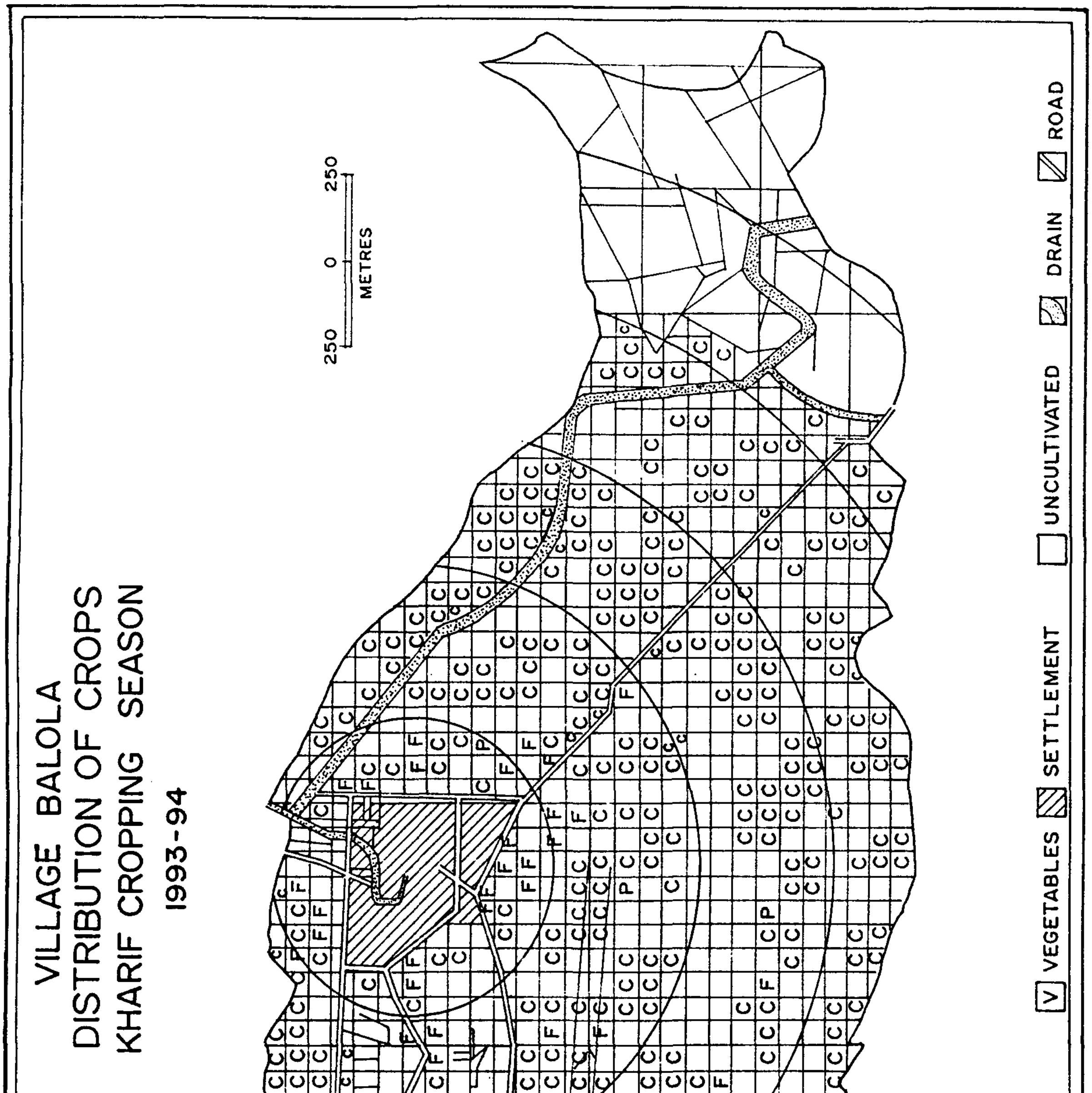

VILLAGE BALOLA
DISTRIBUTION OF CROPS
KHARIF CROPPING SEASON
1993-94
250 0 250
METRES
LEGEND
C CEREALS
F FODDER
P PULSES
V VEGETABLES
SETTLEMENT
UNCULTIVATED
DRAIN
ROAD

Fig. 7.3a

VILLAGE BALOLA
DISTRIBUTION OF CROPS
RABI CROPPING SEASON
1993-94

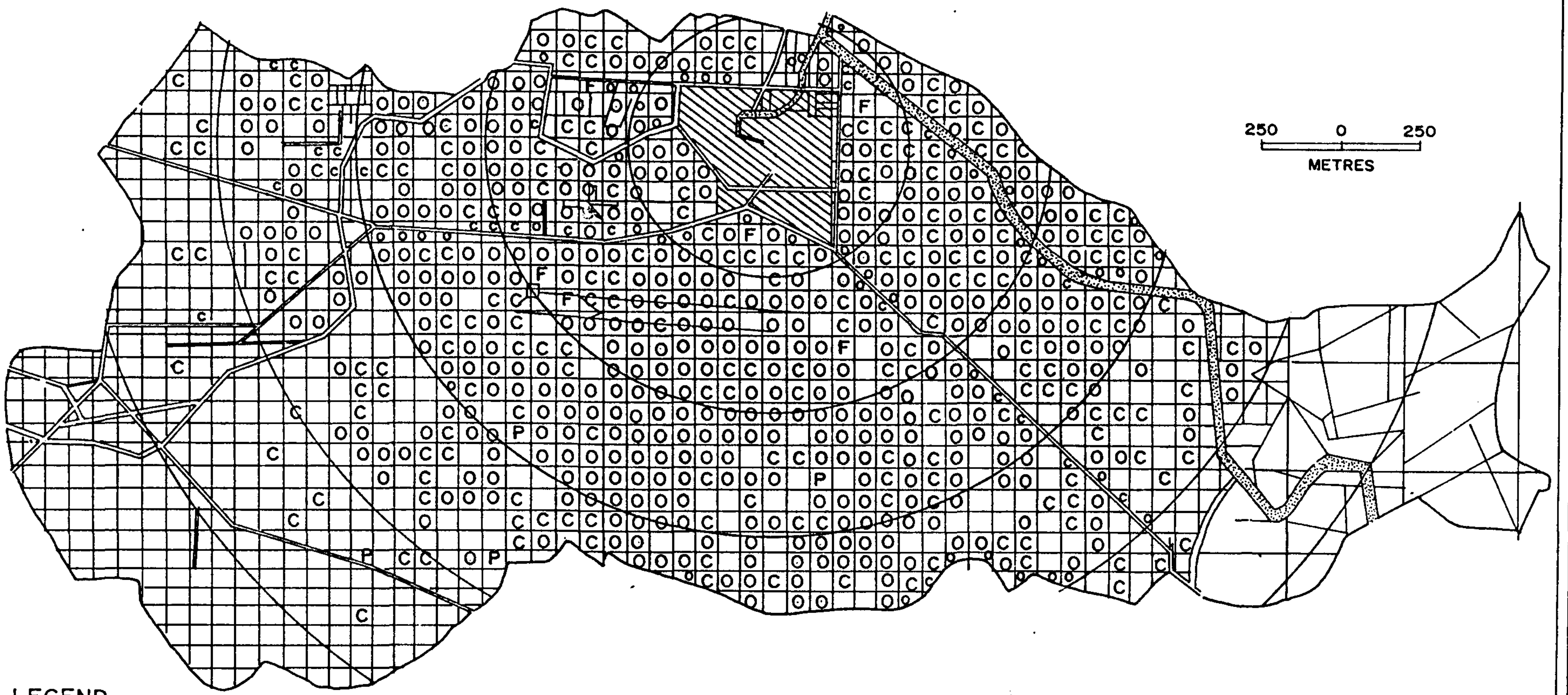


Fig.7.3b

intensity and distance from the village settlement. The scatter plot and the line of least square (Fig. 7.3.1B) exhibits the same relationship of the declining trend of cropping intensity with increasing distance from the village settlement. A very strong negative correlation of -0.96362 along with a negative regression coefficient of -0.00093 confirms the above mentioned relationship.

Moreover, the coefficient of determination is worked out as 0.9286 indicating that 92.86 percent of spatial variation in the cropping intensity is explained by distance from the village settlement. The t-statistic of 7.211 of the regression coefficient shows that regression coefficient is significant at less than 0.01 level of significance. It means that the proportionate decrease in the cropping intensity is real and a result of the impact of distance from the settlement.

This confirms the hypothesis that agriculture becomes extensive with increasing distance from the village. In fact, double cropping a function of assured water supply is greatly affected in this village. It is primarily because 88.88% of the net sown area is rainfall dependent and irrigation is higly limited due to saline nature of sub-soil water. Besides this, the quality of soils, whose fertility generally progressively decreases from the village settlement, is also important factor generating this pattern of cropping intensity.

(b) The area under crops/crop groups and distance from the village settlement.

(i) Cereals (Kharif) - In Balola during Kharif cropping season of 1993-94 only two crops Bajra and Jowar were grown. Bajra ranked first as it occupied about 76% of the total area put to cereal cultivation, while Jowar occupied only about 24% of the area.

The area under cereal crops of Kharif cropping season shows an average tendency of decline with distance (Fig. 7.3.2A). There is a rapid increase in the percentage of area under cereal crops in Zone-II (48.2%) as compared to Zone-I (31.0%). This increase is followed by a decrease to 43.6% in Zone-III, then an increase to 50.6% in Zone-IV, and then a sharp decline to 15.7% and zero percent in Zones-V and VI, respectively. The scatter plot (Fig. 7.3.2B) with least square line also confirms the statement of general confused but apparently declining trend in the distribution of Kharif cereals with increasing distance from the village settlement. A moderate negative correlation of -0.6509 with a negative regression coefficient of -0.0175 further supports the above observation of confused declining trend in the distribution of Kharif cereals.

Though, the coefficient of determination of 0.4237 indicates that 42.37 percent of spatial variation in the distribution of Kharif cereals is explained by distance from the village settlement. The t-statistic of 1.714 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance. It means that the proportionate decrease in the distribution of Kharif cereals is not real and is due to chance.

Hence, the hypothesis that area under Kharif cereals would increase with increasing distance from the village settlement stands rejected for want of proper statistical support. In a strictly rainfed agricultural conditions like that of Balola it becomes extremely difficult for crops to justify their locational distribution in the agricultural landscape of a village. That is why, a weak general declining trend of the locational distribution of Kharif cereals is observed.

(ii) **Cereals (Rabi)** - In Balola during Kharif cropping season of 1993-94 three crops namely wheat with about 80%, barley with about 14% and gram with about 6% of the total area put to cereals cultivation were grown.

The total area under cereal crops of Rabi cropping season shows a sharp declining trend (Fig. 7.3.3A) with respect to increasing distance from the village settlement. However, there is a slight increase in the percentage of area under cereal crops in Zone-IV (25.8%) as compared to Zone-III (16.2%). The scatter plot (Fig.7.3.7B) with least square line also confirms the statement of general declining trend in the distribution of Rabi cereals with increasing distance from the village settlement. A strong negative correlation of -0.88505 with a negative regression coefficient of -0.02364 further strengthens the above mentioned statement.

A negative linear functional relationship between area under Rabi cereals and distance from the settlement is further confirmed the coefficient of determination of 0.7833 indicating that 78.33% of the spatial variation in the distribution of Rabi cereals is explained alone by distance from the village settlement. The t-statistic of 3.803 of the regression coefficient with 4 degrees of freedom also shows that the regression coefficient is significant at less than 0.01 level of significance. This rejects the hypothesis that area under Rabi cereals increases with increasing distance form the village settlement. The reason is very limited irrigation facilities in the outer parts of the village, since high yielding varieties of wheat need assurance of water supply for being cultivated.

(iii) Vegetables (Kharif) - The area under vegetables of Kharif cropping season shows a very steep declining trend (Fig.7.3.1A) with respect to increasing distance from the village settlement. However, the cultivation of vegetables is highly confined only upto Zone-II. The percentage of area under vegetables in Zone-I (5.2%) is higher as compared to Zone-II (0.8%). The scatter plot (Fig.7.3.3B) with least square line also confirms the statement of general declining trend in the distribution of Kharif vegetables with increasing distance from the village settlement. A strong negative correlation of -0.72902 with a negative regression coefficient of -0.00203 further supports the above mentioned statement.

Further, the coefficient of determination of 0.5315 indicates that 53.15% of spatial variation in the distribution of Kharif vegetables is explained by distance from the village settlement. The t-statistic of 2.130 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at more than 0.05 level of significance. It means that the proportionate decrease in the area under Kharif vegetables with distance from the village settlement is real and that the distance is a dominating factor in the cultivation of vegetables.

In this convincing confirmation of the hypothesis, no overt economic consideration is involved except the proximity of tube-wells, and quality of soils, the fertility of which generally decreases away from the village habitat have generated a morphology of economic rent of the land that has caused this patterns of cropping which also lies in full conformity with the Von Thunen's derivations.

Hence, the hypothesis that area under vegetables decreases with increasing distance from the village settlement stands accepted in the case of Balola where rainfed agriculture is dominant.

(iv) **Vegetables (Rabi)** - The area under vegetables of Rabi cropping season in also confined only up to Zone-II like that in Kharif season. It shows a steep declining trend (Fig.7.3.4A) with respect to increasing distance from the village settlement. The scatter plot (Fig.7.3.8B) with least square line also confirms the statement of general declining trend in the distribution of Rabi vegetables with increasing distance from the village settlement. A strong negative correlation of -0.7128 with a negative regression coefficient of -0.0013 further supports the above mentioned statement.

The coefficient of determination of 0.5081 from the regression analysis indicates that 50.81% of spatial variation in the distribution of Rabi vegetables is explained by distance from the village settlement. The t-statistic of 2.033 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It means that the distance from the village settlement is an important determinant of localization of Rabi vegetables.

This confirmation of the hypothesis, results from the consideration of quality of soil and ease to take care of vegetables in the field.

(v) **Oil seeds (Rabi)** - The area under oil seeds in Rabi cropping season shows a steep declining trend (Fig.7.3.3A) with respect to increasing distance from the village settlement. However, there is an increase in the percentage of area under oil seeds in Zone-II (71.1%) as compared to Zone-I (58.6%). The scatter plot (Fig.7.3.9B) with least square line also confirms the statement of general declining trend in the distribution of Rabi oil seeds with increasing distance from the village settlement. A very strong negative correlation of -0.88313 with a negative regression coefficient of -0.03819 further supports the above observation.

The robustness of this functional relationship is further verified by as high a coefficient of determination as 0.7799 which indicates that 77.99% of spatial variation in the distribution of Rabi oil seeds is explained by distance from the village settlement. The t-statistic of 3.765 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significantly different from zero at 0.01 level of significance. It means that the decrease in the distribution of Rabi oil seeds is real and is not due to chance. During Rabi season out of the total cultivated 405 hectares of land, 203 hectares were under oil seeds. This shows that the economic considerations are involved in the cultivation of Rabi oil seeds. That is why it occupies a greater portion of land even in the inner zones of cultivation. Hence, outer zones of cropping are either completely left vacant or they are represented by oil seeds on a very small scale. This explains why a crop which requires less amount of water, is not showing extensification with the increasing distance from the village settlement.

Hence, the hypothesis that area under oil seeds increases with increasing distance from the village settlement stands rejected in the case of Balola.

(vi) **Fodder (Kharif)** - The area under fodder crops of Kharif cropping season shows a definite declining trend (Fig.7.3.2A) with respect to increasing distance from the village settlement. The scatter plot (Fig.7.3.5B) with least square line also confirms this statement. A strong negative correlation of -0.77281 with a negative regression coefficient of -0.01106 further strengthens the above mentioned statement.

The linear strong relationship between distance and area under fodder crops is supported by the regression analysis that has yielded a coefficient of determination of 0.5972 indicating that 59.72% of spatial variation in the distribution of Kharif fodder is explained by distance from the village settlement. The t-statistic of 2.435 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance.

It means that the hypothesis that area under fodder crops increases with increasing distance from the village settlement stands rejected in the case of Balola. The percentage of area put to fodder crops in Kharif season ranks second in Zones-I, II, III and IV after Kharif cereals, this shows that much emphasis is being placed on dairy farming in the village in order to cater the needs for milk and milk products of the population of Delhi which is just 9 kilometers away from this village. Thus, the Kharif fodder crops are significant in the economy of the village and find a respectable place in the cropping practices of the village. Therefore, they occupy more space in good quality land nearby the village settlement.

(vii) **Fodder (Rabi)** - The area under fodder crops of Rabi cropping season though confined only to Zone-I, II and III shows a steep declining trend (Fig.7.3.4A) with respect to increasing distance from the village settlement. However, the area under fodder cultivation as compared to other crops during the Rabi season ranks third in Zone-I and II after cereals and oil seeds. While in Zone-III it ranks fourth after cereals, oil seeds and pulses. The scatter plot (Fig.7.3.10B) with least square line also confirms that there is a sharp declining trend in the distribution of Rabi fodder crops with increasing distance from the village settlement. A strong negative correlation of -0.8286 with a negative regression coefficient of -0.00149 further supports the above observation .This relationship is as strong as the coefficient of determination of 0.6866 which indicates that 68.66% of spatial variation in the distribution of Rabi fodder is explained by distance from the village settlement. The t-statistic of 2.9604 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance.

Hence, the hypothesis that area under fodder crops increases with increasing distance from the village settlement is unacceptable in the case of Balola. The main reasons being the same as highlighted in the case of Kharif fodder crops. A low concentration of the fodder crops in Rabi seasons is a feature of their distribution which is mainly due to lack of irrigation facilities.

(viii) **Pulses (Kharif)** - The area under pulses of Kharif cropping season shows a continous declining trend (Fig.7.3.1A) with respect to increasing distance from the village settlement ranging from 1.7% in Zone-I to 0.5 % in Zone-V. In Zone-VI no area is village settlement. There is a slight increase in the percentage of area under pulses in Zone-III (0.7%) as compared to Zone-II (0.0%). In Zone-IV the area under pulses is relegated to 0.4%, and then rises to 0.5% in Zone-V. The scatter plot (Fig.7.3.11B) with least square line also confirms the statement of general confusing trend of the distribution of Rabi pulses with increasing distance from the village settlement. A weak positive correlation of 0.20847 with a positive regression coefficient of 0.000086 further supports the above observation. This is also confirmed by a very small coefficient of determination of 0.0435 indicating that only 4.35 percent of spatial variation in the distribution of Rabi pulses is explained by distance from the village settlement. The t-statistic of 0.4263 of the regression coefficient shows that the regression coefficient is not significantly different from zero. Hence, the hypothesis that area under pulses increases with increasing distance from the village settlement stands rejected in the case of Balola. In Rabi after cereals and oil seeds, important components of the village economy are vegetables and fodder crops. Pulses are the last choice of farmers. Their appearance on the villgae is therefore, negligible.

Concluding the findings of this village Balola it may be stated that under the strained rainfed agriculture the hypotheses formulated came true only in respect of intenstiy of cropping and vegetables of Rabi and Kharif seasons. The other crops/crop groups could not validate their respective hypotheses.

devoted to the cultivation of pulses. The scatter plot (Fig.7.3.6B) with least square line also verify the statement of general declining trend in the distribution of Kharif pulses with respect to increasing distance from the village settlement. A very strong negative correlation of -0.9785 with a negative regression coefficient of -0.000764 further supports the above mentioned statement

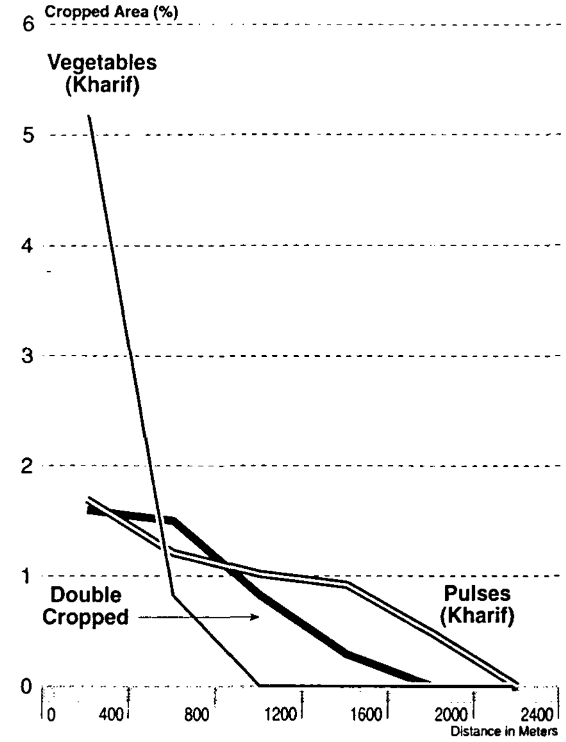
The coefficient of determination of 0.9574 from the regression analysis indicates that 95.74 % of spatial variation in the distribution of Kharif pulses is explained alone by distance from the village settlement. The t-statistic of 9.4818 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.01 level of significance.

Hence, the hypothesis that area under pulses would increase with increasing distance from the village settlement stands rejected in the case of Balola. This finding opposite to the research hypothesis shows that pulses have importance in the village economy as they occupy good quality land. This has resulted from a general lack of irrigation. In the absence of the assured water supply, the Kharif pulses become important as their water requirements are small and they can be grown with small amount of rainfall.

(ix) **Pulses (Rabi)** - The area under pulses in Rabi cropping season though confined to only Zone-III, IV and V shows a confused trend (Fig.7.3.4A) with respect to increasing distance from the

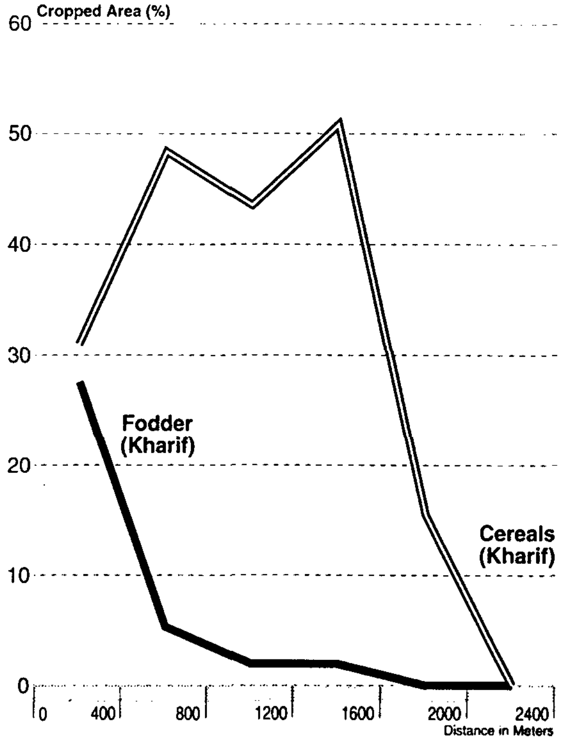
Village: Balola

Distribution of Crops/Cropping Intensity
Sohna (Gurgaon)
1993-94



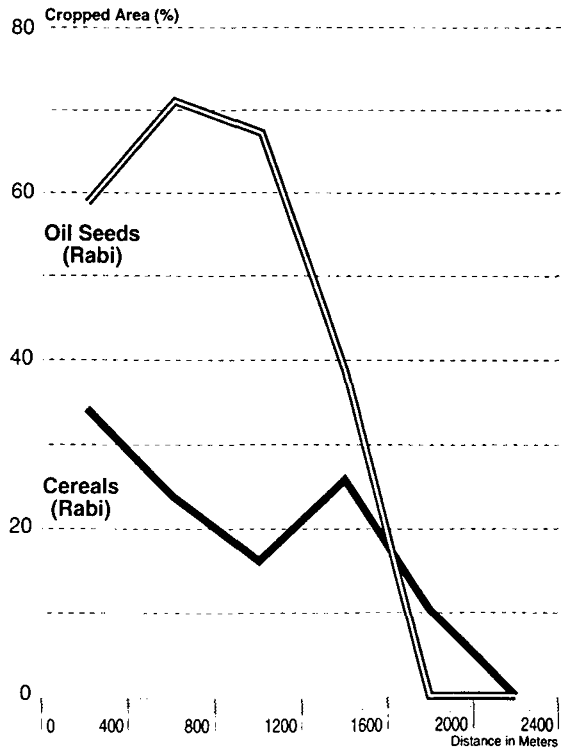
Village: Balola

Distribution of Crops/Cropping Intensity
Sohna (Gurgaon)
1993-94



Village: Balola

Distribution of Crops/Cropping Intensity
Sohna (Gurgaon)
1993-94



Village: Balola

Distribution of Crops/Cropping Intensity
Sohna (Gurgaon)
1993-94

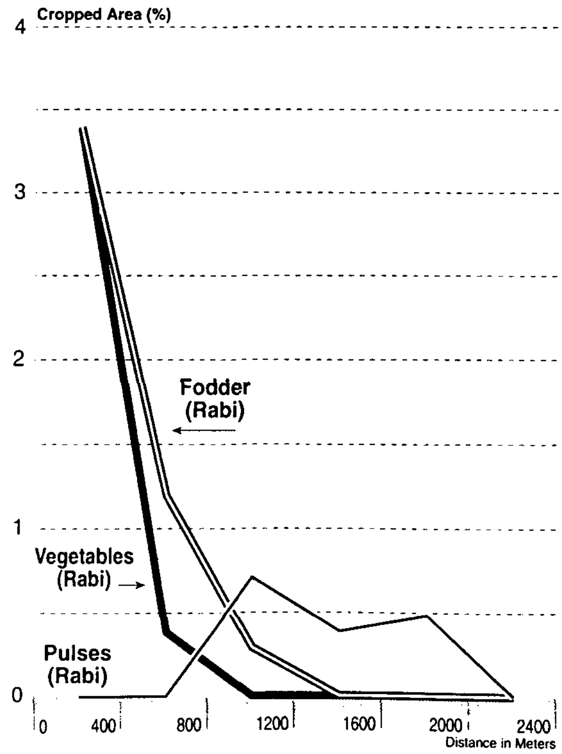


Fig. 7.3

Village Balola

Locational Patterns of Cropping Around Village Settlements

(1993-94)

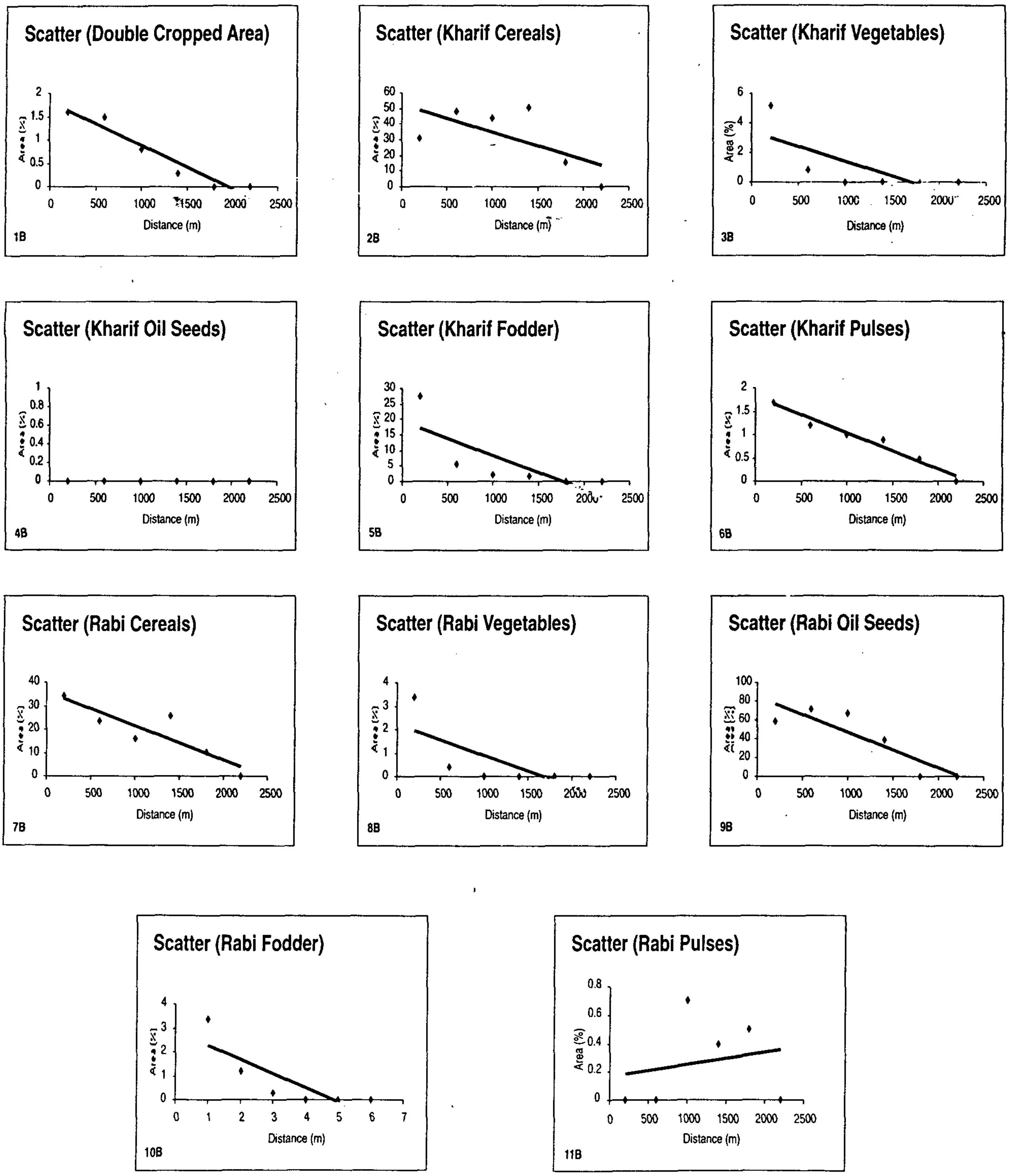


Fig. 7.3

VILLAGE IQBALPUR

The village Iqbalpur with a total area of 195 hectares of land, and a population of 308 persons (Census of India, 1991) is situated in block Farrukhnagar of the district of Gurgaon. Out of 195 hectares, there are two parcels of 10 and 22 hectares of land which are classified as waste land and uncultivable land respectively. During the agricultural calender year 1993-94, the gross cropped area of the village was recorded as 243 hectares collectively for both cropping seasons of Rabi and Kharif. The net sown area was recorded as 163 hectares only.

77.34% of net sown area of the village Iqbalpur is dependent upon rainfall for cropping on account of highly brackish sub-soil water conditions. Only 22.66% of the net sown area is irrigated by tube-wells. Hence, more than 77% of the net sown area depends upon rainfall for cultivation in both cropping seasons of Rabi and Kharif.

The village is 5 kilometers away from the township of Farrukhnagar, and is about 2 kilometers from Farrukhnagar-Gurgaon Road. There is no canal, nearby the village even within a radius of 12 kilometers. Hence, the village Iqbalpur sets an example of a village, in which locational patterns of crops with respect to increasing distance from the village settlement under a greater influence of a transport artery/road can be studied.

The territory of the village is divided into six concentric zones of equal width of 260 meters with respect to the centre of the village settlement for the purpose of this study.

In the village during Kharif cropping season cultivation of oil seeds and pulses was not practiced during 1993-94. Hence, the study of locational patterns of crops/crop groups of Kharif (Fig. 7.4a) and Rabi (Fig. 7.4b) cropping seasons and cropping intensity with respect to increasing distance from the village settlement is taken up. The following conclusions are drawn from this analysis.

(a) Cropping intensity and increasing distance from the village settlement

The study of the graph (Fig.7.4.1A) reveals that there is a definite general declining trend in the cropping intensity as the distance from the village settlement increases. However, there is a slight increase in the intensity of cropping in Zone-II (9.6%) as compared to Zone-I (7.6%). The scatter plot (Fig.7.4.1B) with the line of best fit also represents the same declining trend of cropping intensity. A strong negative correlation of -0.87767 along with a negative regression coefficient of -0.00355 further strengthens the fact that there is an inverse relationship between cropping intensity and distance from the village settlement.

Moreover, the coefficient of determination of 0.7703 indicates that 77.03% of spatial variation in the cropping intensity is explained by distance from the village settlement. The t-statistic of 3.6626 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is statistically significant at more than 0.05 level of significance. It means that the cropping intensity over the village space is largely a function of distance from the settlement.

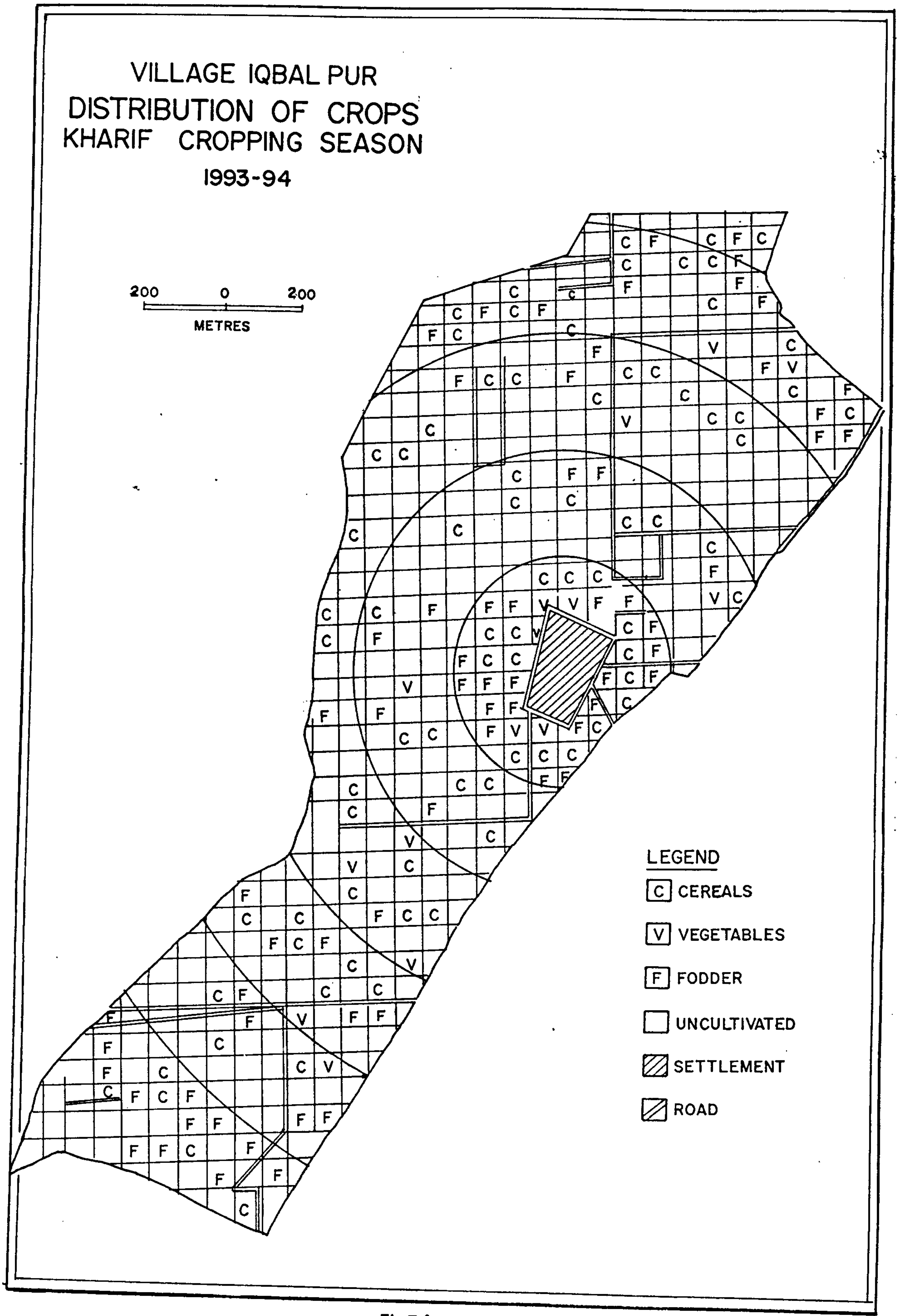

VILLAGE IQBAL PUR
DISTRIBUTION OF CROPS
KHARIF CROPPING SEASON
1993-94
200 0 200
METRES
LEGEND
C CEREALS
V VEGETABLES
F FODDER
UNCULTIVATED
SETTLEMENT
ROAD

Fig.7.4a

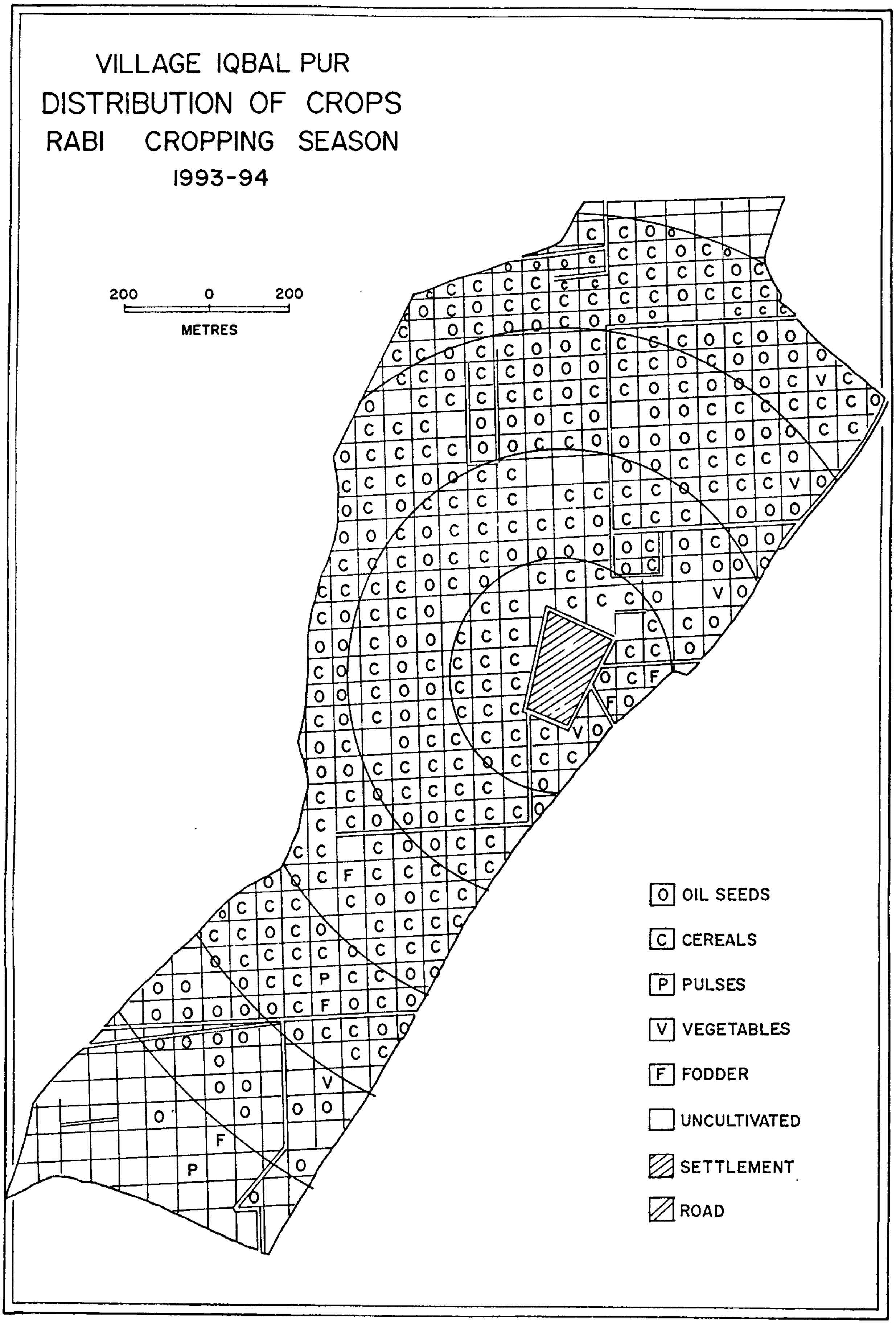

VILLAGE IQBAL PUR
DISTRIBUTION OF CROPS
RABI CROPPING SEASON
1993-94
200 0 200
METRES
O OIL SEEDS
C CEREALS
P PULSES
V VEGETABLES
F FODDER
UNCULTIVATED
SETTLEMENT
ROAD

Fig.7.4b

This convincing confirmation of the hypothesis points out that agriculture gradually becomes some what extensive away from the village settlement. In fact, the location of tube-wells near the settlement and quality of soils, the fertility of which generally decreases away from the village habitat are the most important factors generating this decreasing trend of cropping intensity.

(b) Area under crops/crop groups and distance from the village settlement

(i) Cereals (Kharif) - In village Iqbalpur during Kharif cropping season of 1993-94 only two crops Bajra and Jowar were grown. Bajra accounts for about 93% of the total area put to Kharif cereals while Jowar accounts only about 7% of area of Kharif cereals.

A study of zone wise distribution of Kharif cereals around the village settlement of Iqbalpur reveals a slightly confused but declining trend (Fig.7.4.2A). The scatter plot (Fig.7.4.2B) with least square line also reveals an apparent declining trend well supported by a strong negative correlation of -0.74243 and a negative regression coefficient of -0.01374.

Moreover, the coefficient of determination of 0.5512 indicates that 55.12 % of spatial variation in the distribution of Kharif cereals is explained alone by distance from the village settlement. The t-statistic of 2.21646 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance.

Hence, the hypothesis that area under Kharif cereal crops would increase with increasing distance from the village settlement is not accepted.

(ii) **Cereals (Rabi)** - During Rabi season among the cereals only three crops wheat, barley and gram were cultivated in Iqbalpur village. Out of the total area put to cereals, 89.88% area was invariably occupied by wheat alone, 9.00% by barely and 1.12% by gram.

The area under cereals of Rabi cropping season shows a declining trend (Fig.7.4.3A) with respect to increasing distance from the village settlement. However, there is a slight increase in the percentage of area under cereal crops in Zone-III and IV (51.6% and 61.6%) as compared to Zone-II (50.0%). The scatter plot (Fig.7.4.7B) with least square line also confirms the statements of general declining trend in the distribution of Rabi cereals with increasing distance from the village settlement. A strong negative correlation of -0.81476 with a negative regression coefficient of -0.02364 further supports the statement that there is an inverse relationship between distance from the settlement and area under Rabi cereals.

Moreover, the coefficient of determination of 0.6638 indicates that 66.38 % of spatial variation in the distribution of Rabi cereals is explained by distance from the village settlement. The t-statistic of 2.81049 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. Hence, the hypothesis that area under cereals would increase with increasing distance from the village is rejected and the opposite is accepted. The fact is that, in rainfed agriculture, crops bringing high returns can not be grown and cereals assume importance, therefore, they are cultivated nearby village where soils are of good quality. Moreover, in a wheat dominated structure of Rabi cereals which greatly depends upon assured water supply, is adversly affected in its locational distribution in the rainfed agriculture of the village.

(iii) **Vegetables (Kharif)** - The area under vegetables of Kharif cropping season shows a declining trend (Fig.7.4.1A) with respect to increasing distance from the village settlement. However, there is an increase in the percentage of area under vegetables crops in Zone-IV(4.0%) as compared to Zone-II and III (1.8% and 0.8%). The scatter plot (Fig.7.4.3B) with least square line also confirms the statement of general decreasing trend in the distribution of Kharif vegetables with increasing distance from the village settlement. However, a moderately high negative correlation of -0.6725 does not support this strongly. Moreover, a negative regression coefficient of -0.00466 is found not to be different from zero as its t-statistic of 1.81733 suggests that it is not statistically significant. Moreover, the coefficient of determination of 0.45226 indicates that 45.226% of spatial variation in the distribution of Kharif vegetables is explained by distance from the village settlement. This indicates that distance from the village settlement has little influence on the locational pattern of vegetables. In fact availability of irrigation water besides rainfall is significant in determining the location of vegetables in Kharif season. Hence, the proposition that distribution of vegetables is inversely affected by distance from the village settlement is not accepted for the lack of adequate statistical support. Since, the village Iqbalpur is located nearby a road so the higher concentration of vegetables in the outer zones which are nearer to the road than inner zones, explains that road accessibility also influences locational patterns of crops like vegetables which are perishable in nature.

(iv) **Vegetables (Rabi)** - The area under vegetables of Rabi cropping season shows a confused but somewhat declining trend (Fig.7.4.4A) with respect to increasing distance from the village settlement. However, there is a significant increase in the percentage of area under vegetables in Zone-V (2.1%) as compared to Zone-IV (0.0%). The scatter plot (Fig.7.4.8B) with least square line also confirms a general declining trend in the distribution of Rabi vegetables with increasing distance from the village settlement. However, a weak negative correlation of -0.4675 is not supporting the proposition. Further a negative regression coefficient of -0.00096, with a t-statistic of 1.0057 is found insignificant, meaning thereby that functional relationship established is not confirmed statistically. Moreover, the coefficient of determination of 0.2185 indicates that 21.85% of spatial variation in the distribution of Rabi vegetables is explained by distance from the village settlement. Hence, the hypothesis that area under vegetables would decrease with increasing distance form the village settlement stands rejected in case of Iqbalpur. In case of Rabi vegetables, it is the availability of irrigation water which is more important than rainfall, and is considered a major dreterminant of locational patterns of the Rabi vegetables. Road accessibility also speaks about its significance in the form of more concentration of vegetables in the outer zones which are comparatively nearer to the Farrukhnagar road.

(v) **Oil seeds (Rabi)** - The area under oil seeds of Rabi cropping season shows an average tendency of decline with distance. However, this trend is not clearly perceptible and is rather confusing (Fig.7.4.13A) and is not in conformity with the hypothesis. The scatter plot (Fig.7.4.9B) with least square line also reveals the same indefinite trend in the distribution of Rabi oilseeds with increasing distance from the village settlement. A weak negative correlation of -0.4158 means that there is no strong functional relationship between the Rabi oil seeds and distance form the village settlement.

Moreover, the coefficient of determination of 0.1729 indicates that only 17.29% of the spatial variation in the distribution of Rabi oil seeds is explained by distance from the village settlement. The t-statistic of 0.91449 of the regression coefficient (-0.01153) with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. Hence, the hypothesis that area under oil seeds increases with increasing distance from the village settlement is not accepted in the case of Iqbalpur. For economic reasons, more efforts for the cultivation of vegetables and fodder in zone-VI, coupled with more irrigation facilities have relegated oil seeds to lower levels in the outer zones of production. However, if the cropping status of zone-VI is kept aside, the apparent distribution of Rabi oil seeds will come closer to acceptance level of the hypothesis.

(vi) **Fodder (Kharif)** - The area under fodder crops of Kharif cropping season though found in highly significant proportions, in Zone-I (37.2%), Zone-II (7.2%), Zone-III (4.8%), Zone-IV (18.2%), Zone-V (12.8%) and in Zone-VI (27.3%), yet shows no definite trend of distribution (Fig.7.4.2A) with respect to increasing distance from the village settlement. It is evident from the graph that there is a decrease in the percentage of the area under fodder crops in Zone-II and III as compared to Zone-I, there after it rises in Zone-IV and falls in Zone-V, which is followed by a rise again in Zone-VI. The scatter plot (Fig.7.4.5B) with least square line also confirms this confused trend of fodder distribuition with increasing distance. An extremely weak negative correlation of -0.08297 means that there is no straight line relationship between distance form the village and area under Kharif fodder.

This is further verified by the coefficient of determination of 0.00688 indicating that merely 0.69% of spatial variation in the distribution of Kharif fodder is explained by distance from the village settlement. The t-statistic of 0.16651 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient (-0.000212) is not significant at even more than 0.05 level of significance.

Hence, the hypothesis that area under fodder crops would increase with increasing distance from the village settlement stands rejected in the case of Iqbalpur. The greater allocation of area to the production of fodder crops in rainfed agricultural scenario of the village is attributed to summer monsoon rains primarily, along with the demand for the milk and its products in Farrukhnagar. This also implies that inclination of farmers of this village is towards commercial dairy farming.

(vii) Fodder (Rabi) - The area under fodder crops of Rabi cropping season shows a zig-zag but a rising trend (Fig.7.4.4A) with respect to increasing distance from the village settlement. The area under fodder increases from 0.0% in Zone-I and Zone-II to 0.8% in Zone-III and 1.0% in Zone-IV. In Zone-V it again touches the bottom of 0.0% and in Zone-VI it reaches a maximum value of 2.3%. The scatter plot (Fig.7.4.10B) with least square line also confirms a rising trend in the distribution of Rabi fodder. A moderate postive correlation of 0.6883 with a positive regression coefficient of 0.00129 further supports the postulate that area under fodder crops increases away from the village settlement.

Moreover, the coefficient of determination of 0.4737 indicates that only 47.37% of the spatial variation in distribution of Rabi fodder is explained by distance from the village settlement.

However, the t-statistic of 1.8974 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is not significant at even more than 0.05 level of significance. It means that the proportionate increase in the distribution of Rabi fodder is not real and is due to chance.

Hence, the hypothesis that area under fodder crops increases with increasing distance form the village settlement stands rejected for reasons cited in the case of Kharif vegetables. In rainfed agricultural scenario of Iqbalpur, allocation of more land to the cultivation of fodder in Rabi season in the outer most zone is for economic and commercial motives. It is not an example set for proving the extensification of fodder crops. A good road accessibility to the outer zone of production (Zone-VI) along with more tube-well irrigation facility is perhaps backing up the cultivation of low-value high-bulk crop like fodder more intensively even at the village peripheral areas. This explains the logic of rejection of the hypothesis formulated.

(viii) Pulses (Rabi) - The area under pulses of Rabi season show a zig-zag trend (Fig.7.4.3A) with respect to increasing distance from the village settlement. The scatter plot (Fig.7.4.11B) with least square line though shows a declining trend is not supported by correlation and regression statistics. A weak negative correlation of -0.31239 with a negative regression coefficient of

-0.00121 fails to confirm any definite trend in the distribution of pulses in Rabi cropping season.

Moreover, the coefficient of determination of 0.0976 indicates that only 9.76% of the spatial variation in the distribution of Rabi pulses is explained by distance from the village settlement. The t-statistic of 0.65795 of the regression coefficient with 4 degrees of freedom further shows that the regression coefficient is insignificant at even more than 0.05 level of significance. It means that the observed decrease in the distribution of Rabi pulses is not real and is due to chance.

Hence, the hypothesis that area under pulses increases with increasing distance from the village settlement stands rejected in the case of Iqbalpur. Low yield and comparatively low remunerative value of pulses are the economic compulsions that farmers grow pulses only for home consumption. This explains the subjectivity of farmers' decision as far as locational distribution of pulses is concerned.

Concluding the findings of this village Iqbalpur it may be stated that under strained rainfed agriculture and the influence of good accessibility on account of close proximity to a road, the hypothesis formulated came true only in respect of intensity of cropping, and Kharif vegetables. The other crops/crop groups could not validate their respective hypotheses.

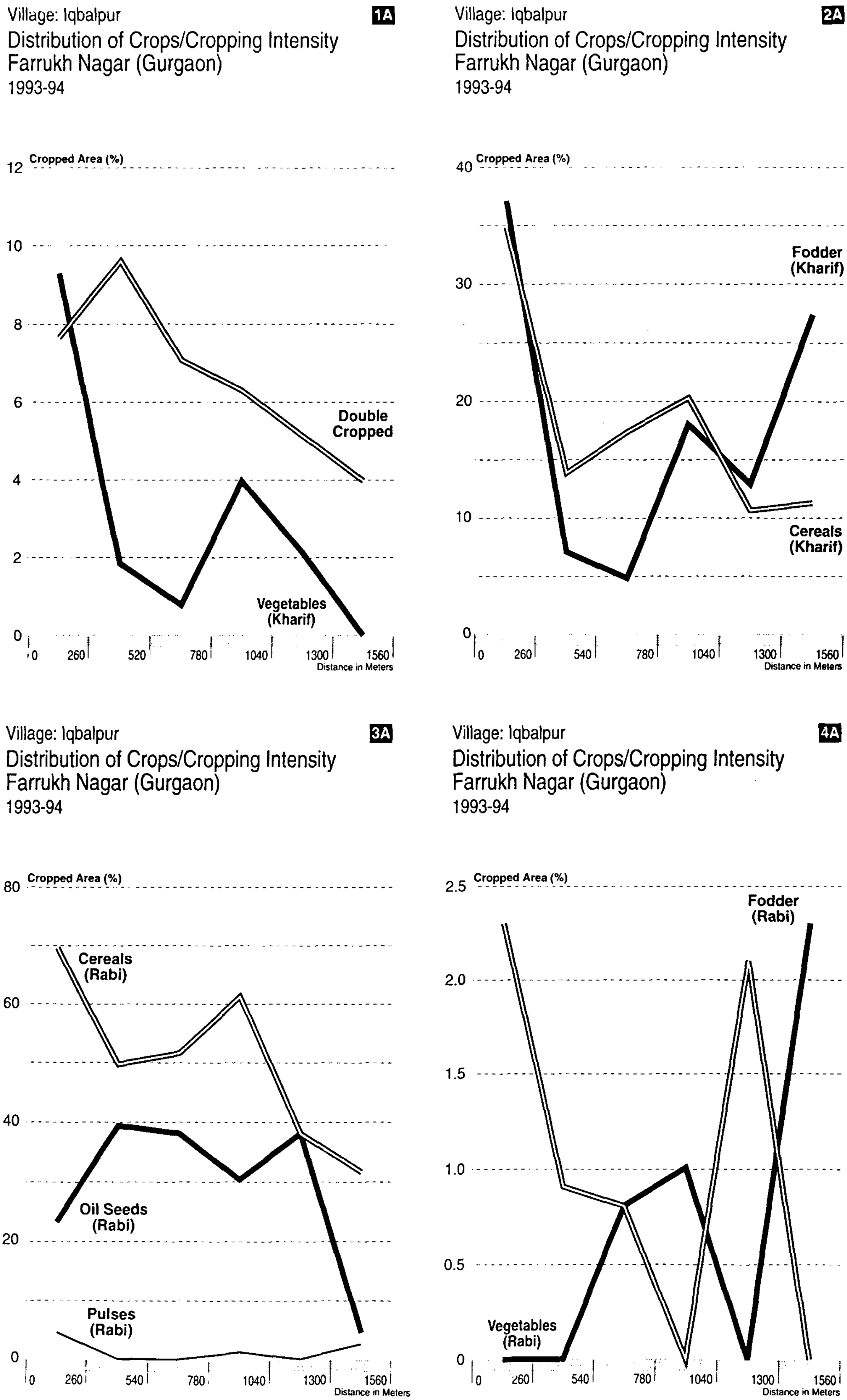

Village: Iqbalpur
1A
Distribution of Crops/Cropping Intensity
Farrukh Nagar (Gurgaon)
1993-94
Cropped Area (%)
12
10
8
6
4
2
0
Double Cropped
Vegetables (Kharif)
0
260
520
780
1040
1300
1560
Distance in Meters
Village: Iqbalpur
2A
Distribution of Crops/Cropping Intensity
Farrukh Nagar (Gurgaon)
1993-94
Cropped Area (%)
40
30
20
10
0
Fodder (Kharif)
Cereals (Kharif)
0
260
540
780
1040
1300
1560
Distance in Meters
Village: Iqbalpur
3A
Distribution of Crops/Cropping Intensity
Farrukh Nagar (Gurgaon)
1993-94
Cropped Area (%)
80
60
40
20
0
Cereals (Rabi)
Oil Seeds (Rabi)
Pulses (Rabi)
0
260
540
780
1040
1300
1560
Distance in Meters
Village: Iqbalpur
4A
Distribution of Crops/Cropping Intensity
Farrukh Nagar (Gurgaon)
1993-94
Cropped Area (%)
2.5
2.0
1.5
1.0
0.5
0
Fodder (Rabi)
Vegetables (Rabi)
0
260
540
780
1040
1300
1560
Distance in Meters

Fig. 7.4

Village Iqbalpur

Locational Patterns of Cropping Around Village Settlements

(1993-94)

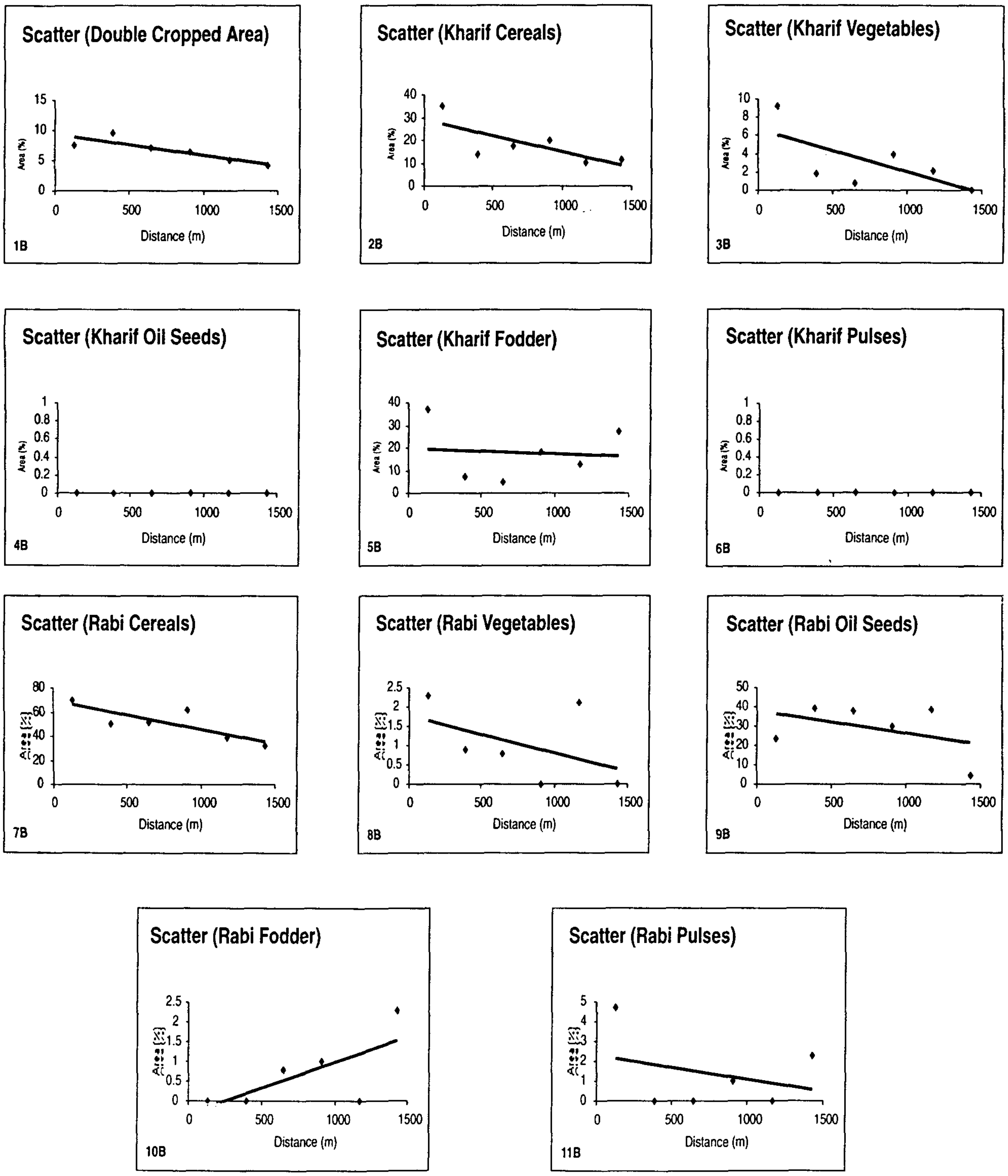


Fig. 7.4

VILLAGE KARAMCHANDPUR

The village Karamchandpur is having a total area of 83 hectares of land. Its population is comprising of 308 persons (Census of India 1991). The village is situated in the community development block of Nuh of the district of Gurgaon. Out of 83 hectares of land, one hectare of land is designated as wasteland and another 12 hectares are recognised as uncultivable land. During the agricultural calender year of 1993-94, the gross cropped area of the village was recorded as 129 hectares collectively for both cropping seasons of Rabi and Kharif. The net sown area was recorded as 70 hectares of land during the same calender year. The cropping intensity for the village was, therefore, worked out to be 45.47%.

The Gurgaon Canal which is quite close to the village presents a perennial source of water for irrigation in both cropping seasons of Rabi and Kharif. The whole of the net area sown is irrigated by the canal.

Hathin, a township in the region is about 8 kilometers away from the village. It is a town which is nearest to the village Karamchandpur. The Nuh-Hodal road is more than 2 kilometers from the village. Hence, the village Karamchandpur sets an example of a village, in which locational patterns of crops under the impact of canal irrigation can be analysed with respect to increasing distance from the village settlement.

The total area of the village Karamchandpur is divided into six concentric zones drawn from the centre of the village settlement. Each zone has a width of 260 meters. However, Zone-I is purposefully made

300 metres wide, in order to contain the large expanse of the village settlement. From the study of the distribution of Kharif crop groups (Fig.7.5a) and Rabi crop groups (Fig.7.5b) and the intensity of cropping following infrences are drawn from this analysis.

(a) The cropping intensity and increasing distance from the village settlement

The study of graph (Fig.7.5.1A) reveals that there is a definite declining trend in cropping intensity as the distance from the village settlement increases. However, this continuous declining trend shows a slight deviation from its intrinsic trend in Zone-II where double cropped area increases to 11.6% from 5.8% in Zone-I. The scatter plot (Fig.7.5.1B) with least square line also depicts the same declining trend of cropping intensity with increasing distance from the village centre. A strong negative correlation of -0.7808 with a negative regression coefficient of -0.00612 further supports the above statement. The coefficient of determination of 0.6096 from the regression analysis indicates that 60.96% of spatial variation in the cropping intensity is explained alone by distance from the village settlement. Further, t-statistic of 2.4993 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It means that the functional relationship between the cropping intensity and the distance from the village settlement really exists in this village.

This is a convincing confirmation of the hypothesis, that intensive

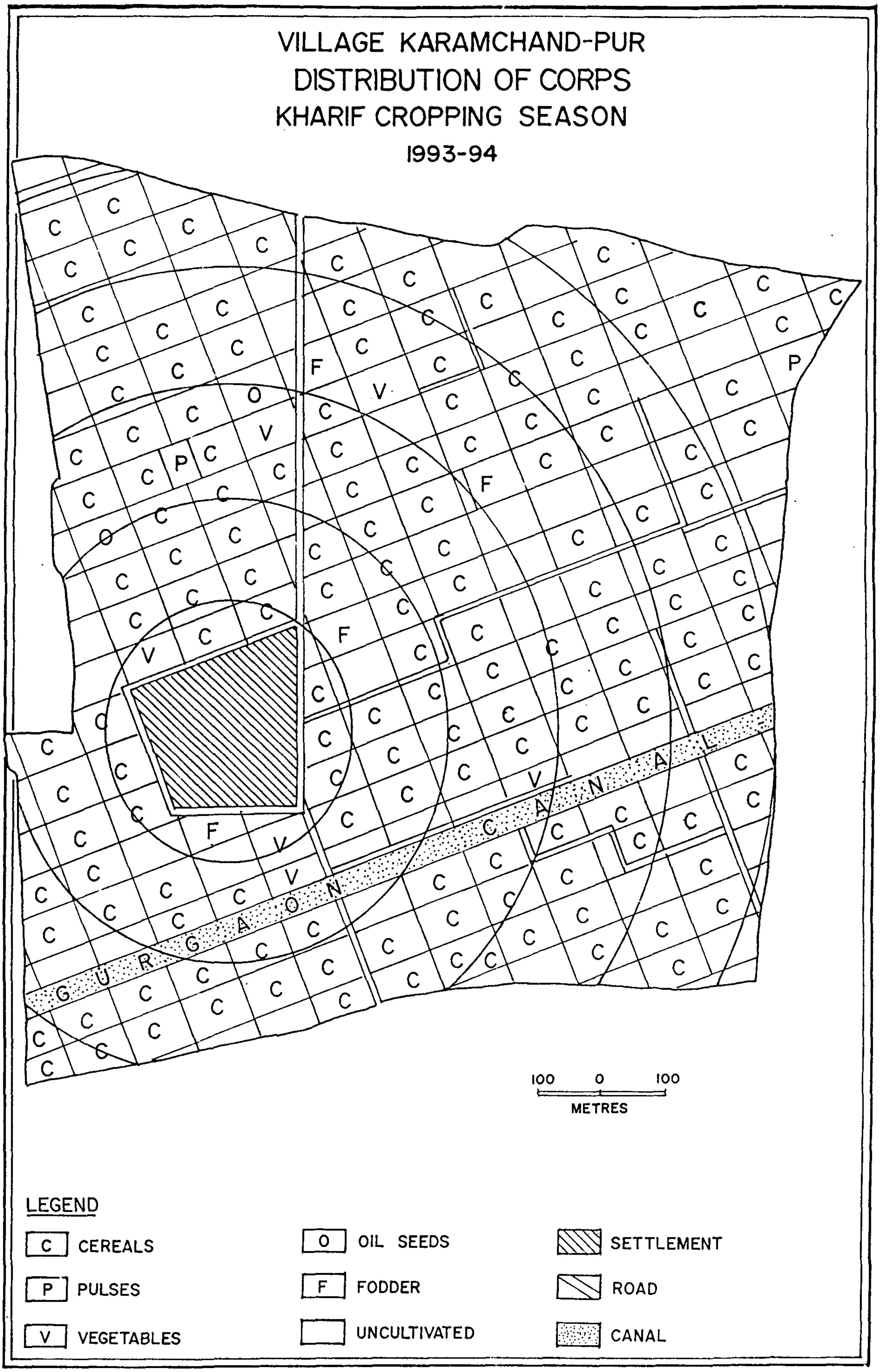
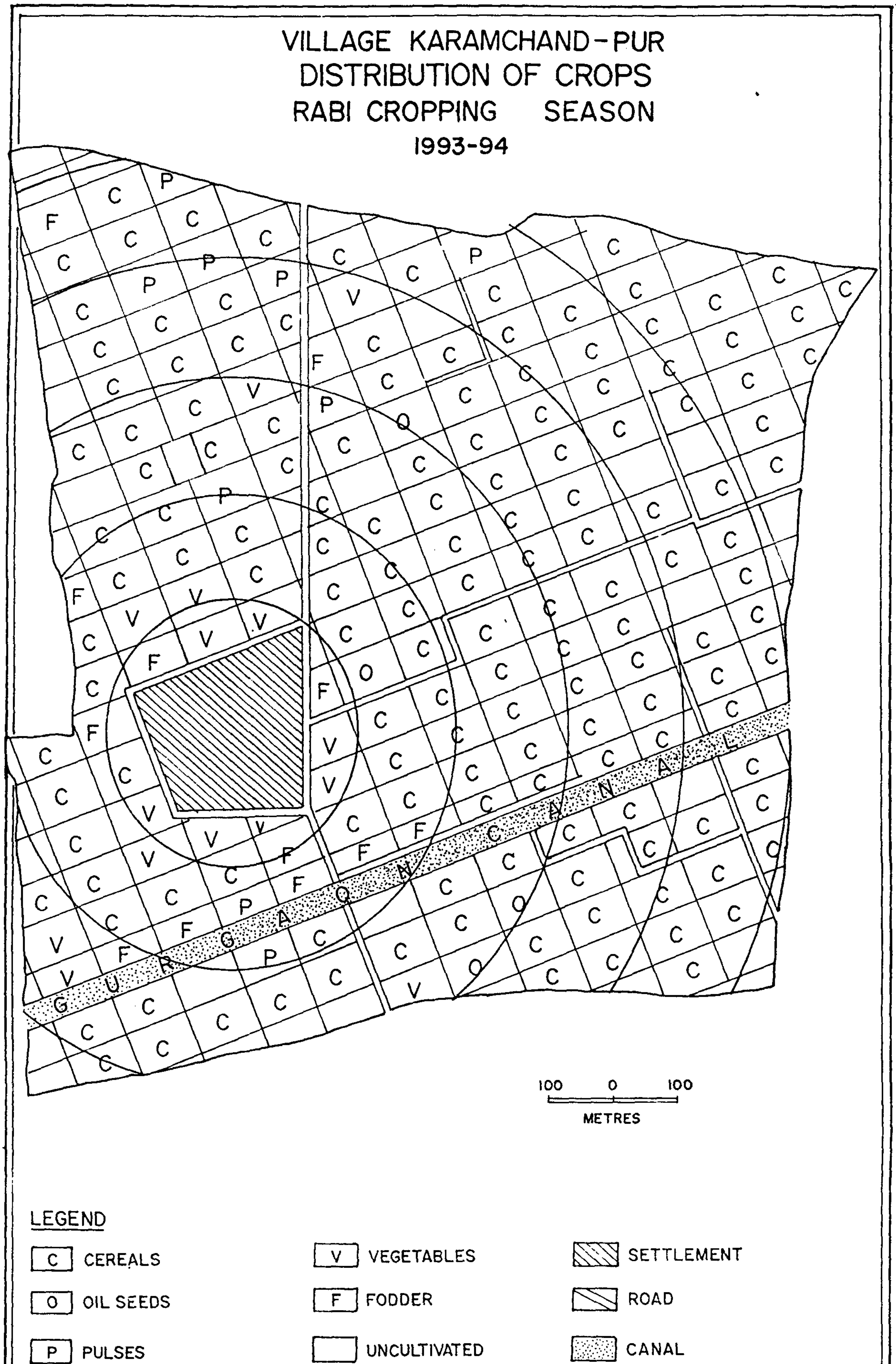

VILLAGE KARAMCHAND-PUR
DISTRIBUTION OF CORPS
KHARIF CROPPING SEASON
1993-94
GURGAON CANAL
100 0 100
METRES
LEGEND
C CEREALS
P PULSES
V VEGETABLES
O OIL SEEDS
F FODDER
UNCULTIVATED
SETTLEMENT
ROAD
CANAL

Fig. 7.5a


VILLAGE KARAMCHAND-PUR
DISTRIBUTION OF CROPS
RABI CROPPING SEASON
1993-94
GURGAON CANAL
100 0 100
METRES
LEGEND
C CEREALS
O OIL SEEDS
P PULSES
V VEGETABLES
F FODDER
UNCULTIVATED
SETTLEMENT
ROAD
CANAL
Fig.7.5 b

cropping takes place near the village settlement and it gradually becomes extensive in the outer parts of the village.

(b) The area under crops/crop groups and distance from the village settlement.

(i) Cereals (Kharif) - In Karamchandpur during Kharif cropping season of 1993-94, only paddy was cultivated. The area under paddy (Fig.7.5.1A) though occupies a significant position among all the Kharif crops, seems to establish a weak relationship with increasing distance from the village settlement. The area under Kharif cereals increases in Zones-II and III (80.0% and 85.4%) as compared to Zone-I (61.5%) and decreases in Zones-IV, V, and VI (89.6%, 63.0% and 56.3%). The scatter plot (Fig.7.5.2B) with least square line also represents no significant trend of paddy distribution with respect to increasing distance from the village settlement. A weak negative correlation coefficient of -0.43731 and a negative regression coefficient of -0.00884 make the above observation more clear.

The coefficient of determination is also very small amounting to 0.1912 which means only 19.12% of spatial variation in the distribution of Kharif cereals is explained by distance from the village settlement. The t-statistic of 0.9725 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is statistically insignificant at even more than 0.05 level of significance. It implies that there exists no relationship between area under paddy and distance from the village settlement.

Hence, the hypothesis that area under cereals would increase with increasing distance from the village settlement is not confirmed by the regression analysis. In fact, paddy is a wet crop that needs a lot of water. Therefore, area under paddy depends greatly on the proximity of the source of water. In case of the present village, canal irrigation is an important determinant of the locational pattern of the paddy crop. Therefore, the morphology of economic rent of the land controlled by the proximity to the settlement is greatly modified by the availability of water supply and has a great bearing on the locational pattern of the paddy crop.

(ii) **Cereals (Rabi)** - In Karamchandpur during Rabi cropping season of 1993-94, only wheat was grown as a cereal crop. The distribution of which shows a mild tendency (Fig.7.5.3A) to increase with increasing distance from the village settlement. However, a decrease is observed in the percentage of area under wheat in Zone-V (67.4%) as compared to Zone-IV (82.6%). The scatter plot (Fig.7.5.7B) with least square line does not confirm the statement of a general increasing trend in the distribution of Rabi cereals with increasing distance from the village settlement. A positive correlation of 0.65021 is moderate. The regression coefficient, though positive (0.03183), is very small.

This is further confirmed by the fact that the t-statistic of the regression coefficient is only 1.71163 which means that the regression coefficient is insignificant at more than 0.05 level of significance. However, coefficient of determination is of moderate order explaining 42.48% of the existing locational pattern of wheat in the present village. It means that distance from the settlement is not a dominating factor underlying the locational pattern of wheat in Karamchandpur. There are certain other guiding influences like declining quality of canal irrigation with distance which define farmers' decision to cultivate wheat in the Rabi season. So in a village atmosphere in which irrigation is assured, wheat is cultivated as a part of commercial grain farming. Being a staple diet of the people of the study area, it is also grown by small farmers as a part of subsistence agriculture. The distribution of Rabi cereals show little variation from village settlement. A comparative increase in the area under Rabi cereals with increasing distance, though, lies in conformity with the postulate is not accepted for want of proper statistical ssupport.

(iii) **Vegetables (Kharif)** - The area under vegetables of Kharif cropping season is confined to only Zone-I, Zone-III and Zone-IV. It shows a zig-zag but a latent decreasing trend (Fig.7.5.2A) with respect to distance from the village settlement. There is no area under vegetables in Zone-II. There is 7.7% area under vegetables in Zone-I. In Zones-III and IV, the area increases to 2.1% and 2.2%, respectively. The scatter plot (Fig.7.5.3B) with least square line exhibits a decissuereasing trend of zone-wise acreage under vegetables. It is supported by a moderately high negative correlation of -0.6877 and a negative regression coefficiant of -0.00366. Moreover, the coefficient of determination of 0.4729 indicates that 47.29 percent of spatial variation in the distribution of Kharif vegetables is explained by distance from the village settlement. But t-statistic of 1.8945 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at even more than 0.05 level of significance. As such there is no established relationship between area under vegetables and distance from the village settlement. The fact is that vegetables demand frequent visits by the farmers for protection and being labour intensive nature of vegetables their locational pattern shows a combined effect of the distance from the village settlement and irrigation source. This explains an indefinite locational pattern of the Kharif vegetables in Karamchandpur instead of that with a declining trend with increasing distance from the village settlement.

(iv) **Vegetables (Rabi) -** The area under vegetables in Rabi cropping season shows a steep declining trend (Fig.7.5.4A) with respect to increasing distance from the village settlement. The scatter plot (Fig.7.5.8B) with least square line also confirms the statement of general declining trend in the distribution of Rabi vegetables. A strong negative correlation of -0.82178 with a negative regression coefficient of -0.02178 further supports the above observation.

Moreover; the coefficient of determination of 0.6753 indicates that 67.53% of spatial variation in the distribution of Rabi vegetables is explained alone by distance from the village settlement. The t-statistic of 2.8844 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It implies that distance exerts a stronger influence on the Rabi vegetables. Since, village settlement and canal, both are very close to each other, hence, a combined influence of both is translated in the form of distributional trend of Rabi vegetables. On the whole, the hypothesis, that area under vegetables decreases with increasing distance from the village settlement is accepted in the case of Karamchandpur.

(v) **Oil seeds (Kharif)** - The area under oil seeds of Kharif cropping season in Karamchanpur is confined to only Zone-II (2.9%) and Zone-IV (2.2%). It shows no definite trend (Fig.7.5.2A) with respect to increasing distance from the village settlement. The scatter plot (Fig.7.5.4B) with least square line though exhibits a declining trend, is not supported by correlation and regerssion statistics. The correlation coefficient as weak as -0.26019 and a negative regression coefficient of -0.000619 are statistically insignificant as its t-statistic of 0.5389 suggests that it is not significantly different from zero at 0.05 level of significance. Further a small coefficient of determination of 0.0677 indicates that only 6.77 % of spatial variation in the distribution of Kharif oil seeds is explained by distance from the village settlement.

The proposition that distribution of oil seeds would increase with distance from the village settlement is not accepted.

(vi) **Oil seed (Rabi)** -The area under oil seeds of Rabi cropping season is showing a continuous increasing trend (Fig.7.5.3A) with respect to increasing distance from the village settlement with only one exception in Zone-IV where a decline in the area is recorded (2.2%) as compared to Zone-III (4.2%). The scatter plot (Fig.7.5.9B) with least square line also confirms a rising trend in the distribution of Rabi oil seeds. A strong positive correlation of 0.8775 with a positive regression coefficient of 0.01105 further supports the above mentioned statement. The regression analysis as indicated by the coefficient of determination explains 77.0% of the spatial variation in the distribution of Rabi oil seeds is alone explained by distance from the village settlement. The t-statistic of 3.6597 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It implies, that the hypothesis, that area under oil seeds increases with increasing distance from the village settlement, stands accepted. This statistical confirmation of the postulate explains that there are economic considerations, to which farmers responed. In fact Rabi oil seed crops like rape seed and mustard are highly remunerative both in terms of yield and monetary gains.

(vii) **Fodder (Kharif)** - The area under fodder crops of Kharif cropping season shows a declining trend (Fig.7.5.1A) with respect to increasing distance from the village settlement. However, there is a slight increase in the percentage of the area occupied by fodder crops in Zone-IV (2.2%) as compared to Zone-III (0.0%). The scatter plot (Fig.7.5.5B) with least square line also confirms the statement of general declining trend in the distribution of Kharif fodder with increasing distance from the village settlement. A strong negative correlation of -0.7997 with a negative regression coefficient of -0.00429 further supports the above mentioned statement.

Moreover, the coefficient of determination of 0.6395 indicates that 63.95% of the spatial variation in the distribution of Kharif fodder is explained alone by the distance from the village settlement. The t-statistic of 2.6639 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It means that the proportionate decrease in the distribution of Kharif fodder is real and is not due to chance.

Hence, the hypothesis that area under fodder crops increases with increasing distance from the village settlement stands unaccepted in the case of village Karamchandpur. It appears that the fodder crops are intensively grown in the village as they occupy good quality land near the village settlement. In fact they are also somewhat intensively cultivated at the source of irrigation, the canal. It means that the influence of both canal and village settlement on the locational distribution of fodder crops is overwhelming.

(viii) Fodder (Rabi) - The area under fodder of Rabi cropping season shows a steep declining trend (Fig.7.5.4A) with respect to increasing distance from the village settlement. The scatter plot (Fig.7.5.10B) with least square line also confirms the statement of steep declining trend in the distribution of Rabi fodder with increasing distance from the village settlement. A strong negative correlation of -0.79 with a negative regression coefficient of -0.01648 strengthens the above observation. Moreover, the coefficient of determination of 0.6244 indicates that 62.44% of the spatial variation in the distribution of Rabi fodder is explained alone by distance from the village settlement. The t-statistic of 2.5786 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance.

It means the hypothesis that area under fodder crops increases with increasing distance from the village settlement stands unaccepted in the case of village Karamchandpur. The production of fodder crops on the prime land nearby the village habitat, and canal as well, points out that farmers of the village are practicing commercial dairy farming.

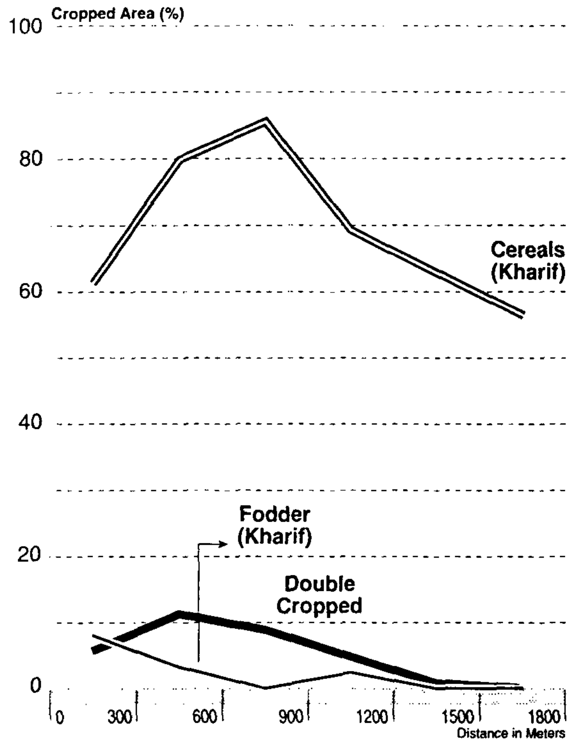
(ix) **Pulses (Kharif)** - The area under pulses of Kharif cropping season is confined to only Zones-III, IV and VI with an area of 2.1%, 2.2% and 6.3% respectively. It shows a zig-zag trend (Fig.7.5.2A) with respect to increasing distance from the village settlement. The scatter plot (Fig.7.5.6B) with least square line shows a small tendency of a rising trend in the distribution of Kharif pulses with increasing distance from the village settlement, but it is not confirmed statistically. As a moderate positive correlation of 0.58713 with a positive regression coefficient of 0.0030 are not significant. The t-statistic of regression coefficient (1.8915) indicates that with 4 degrees of freedom it is insignificant at 0.05 level of significance. However, the coefficient of determination of 0.4721 indicates that only 47.21% of the spatial variation in the distribution of Kharif pulses is explained by distance from the village settlement.

Thus, the hypothesis that area under pulses increases with increasing distance from the village settlement is not accepted in the case of Karamchandpur. The apparent increase in the area of pulses with distance which statistically could not be proved true is perhaps on account of decreasing fertility of soil from the village settlement. Consequently it has helped diversification of the Kharif pulses.

(x) **Pulses (Rabi)** - The area under pulses in Rabi cropping season shows a zig-zag trend (Fig.7.5.3A) with respect to increasing distance from the village settlement like that observed in the case of Kharif pulses. From Zone-I to Zone-VI it follows a sequence of increase, decrease, increase, increase and a decrease. The scatter plot (Fig.7.5.11B) with least square line also confirms the statement of confused trend in the distribution of Rabi pulses with increasing distance from the village settlement. A very weak positive correlation of 0.08695 with a positive regression coefficient of 0.00044 further supports the above mentioned statement. Moreover, the coefficient of determination of 0.00756 indicates that merely 0.76% of the spatial variation in the distribution of Rabi pulses is explained by distance from the village settlement. The t-statistic of 0.1746 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at 0.05 level of significance.

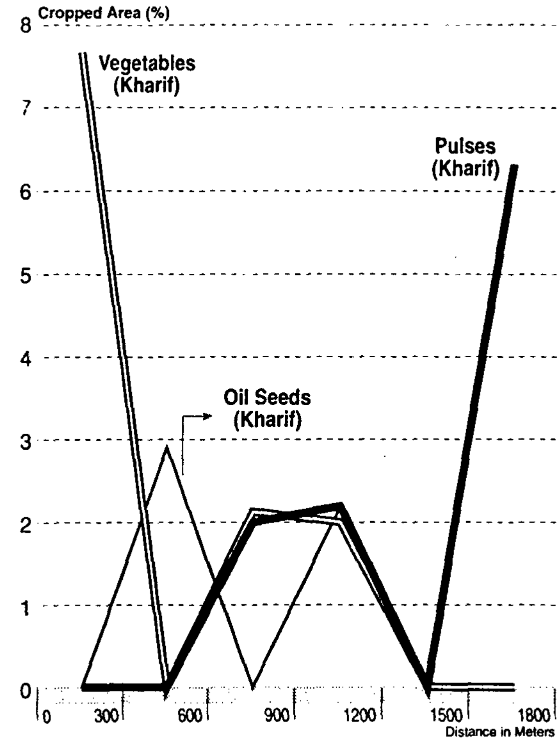
Village: Karamchandpur **1A**

Distribution of Crops/Cropping Intensity
Nuh (Gurgaon)
1993-94



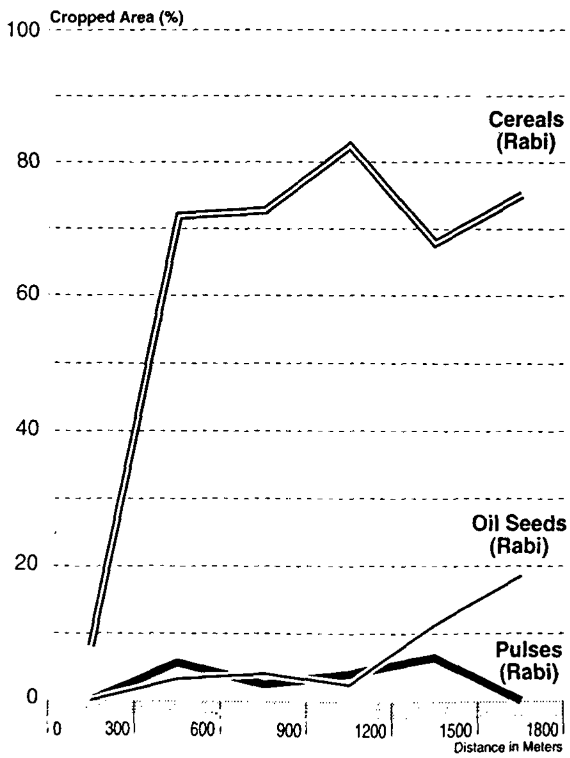
Village: Karamchandpur **2A**

Distribution of Crops/Cropping Intensity
Nuh (Gurgaon)
1993-94



Village: Karamchandpur **3A**

Distribution of Crops/Cropping Intensity
Nuh (Gurgaon)
1993-94



Village: Karamchandpur **4A**

Distribution of Crops/Cropping Intensity
Nuh (Gurgaon)
1993-94

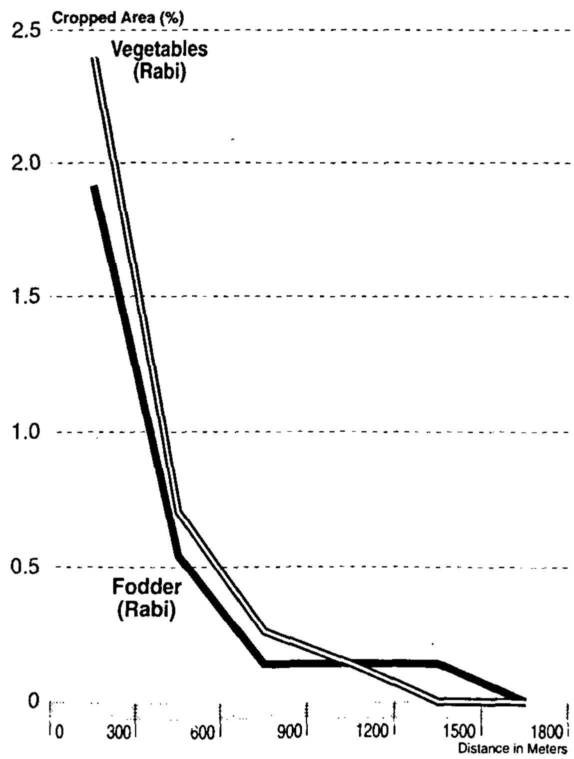


Fig. 7.5

Village Karamchandpur

Locational Patterns of Cropping Around Village Settlements

(1993-94)

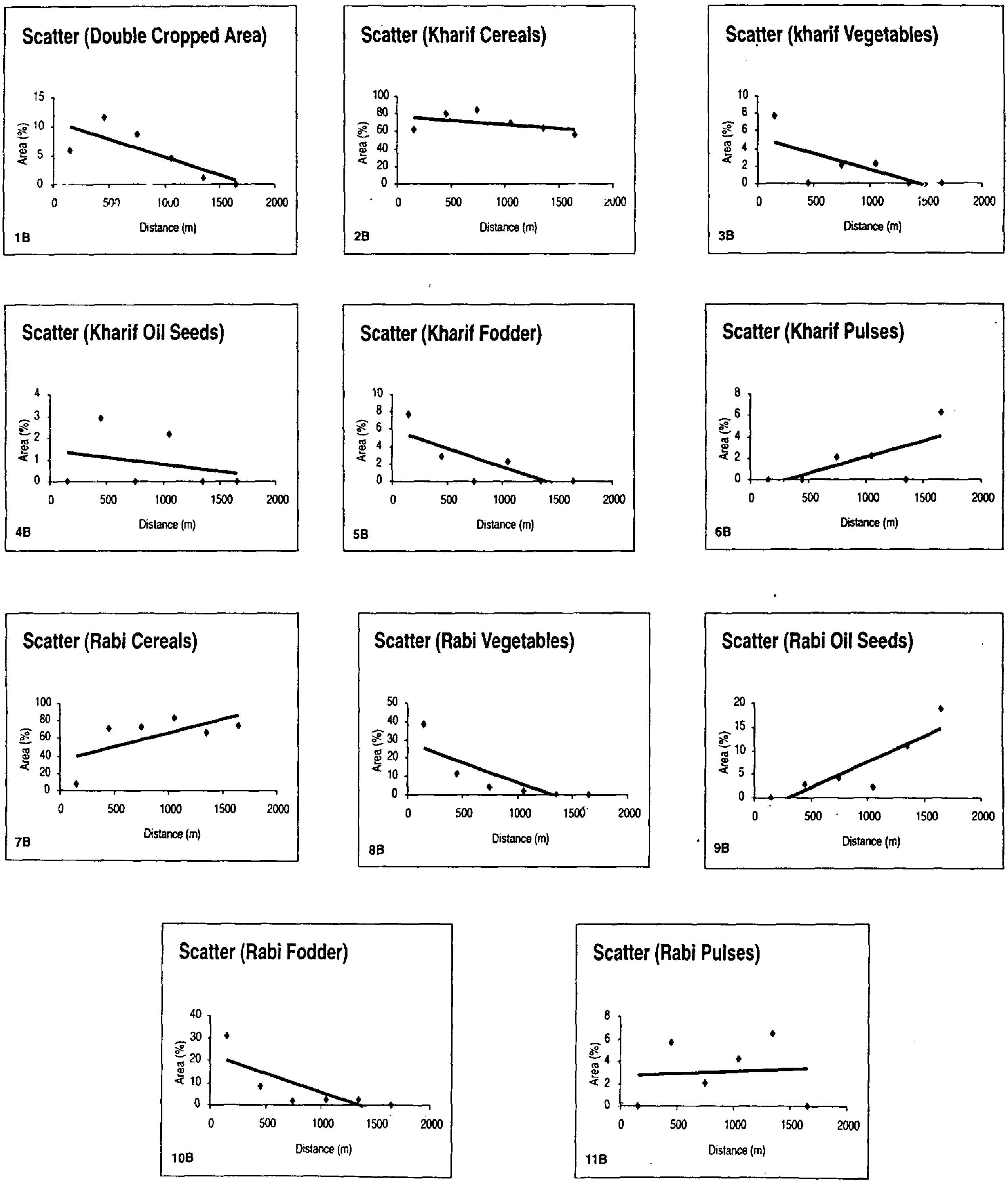


Fig. 7.5

Hence, the hypothesis that area under pulses increases with increasing distance from the village settlement stands rejected for weak statistical support in case of village Karamchandpur. In this village where water supply for irrigation through canal is assured, the cultivation of pulses apparently shows neither extensification nor intensification. However, their concentration is more in all the zones of production except zone-I and VI. It meas that pulses are grown for commercial reasons besides for home consumption.

Concluding the findings of this village Karamchandpur, it may be stated that under the influence of canal irrigation, the hypothesis formulated came true is respect of intensity of cropping, Rabi cereals, vegetables of Rabi and Kharif, and oil seeds of Rabi and the pulses of Kharif cropping season. The other crops/crop groups could not validate their respective hypotheses.

VILLAGE SILOKHRA

Silokhra village with a geographical area of 355 hectares of land is situated in block Gurgaon of the district of Gurgaon. Its population is 1986 persons (Census of India,1991). Out of 355 hectares, about 75 hectares lie as waste land, while other 32 hectares are classifed as uncultivable land. During the agricultural calender year 1993-94, an area of 252 hectares of land was put to cropping collectively in both cropping seasons of Kharif and Rabi. The net sown area for the same calender year was 248 hectares. Hence, only a meagre portion of 4 hectares (1.6%) was designated as double cropped area.

In the village about 91.63% of the net area sown is irrigated by tube-wells. Only 11.7% of the net sown area is left unirrigated. Silokhra village is lying within a radius of about 2 kilometers from the city of Gurgaon itself and is well under the influence of Delhi which is about 30 kilometers from the village. The better connectivity with roads and railway, and a less than 2 kilometers distance from the state highway, are some of the conditions which make this village suitable for the study of locational patterns of cropping under the influence of big urban centre, good accessibility and excellent irrigation.

The whole of the village area is divided into six concentric zones each of 350 meters width drawn from the centre of the village settlement for this study.

A significant feature of this village is that there are two village settlements within its bounds. The northern is older than the southern settlement. Taking the core of the northern village settlements six concentric zones were drawn. However, one zone of the same width was also drawn around the southern settlement from its core. The area lying under the Zone-1 of the twin settlements is clubbed together for further analysis. The analysis carried out on this village for studying locational distribution of crop groups of Kharif cropping season (Fig.7.6a) and Rabi cropping season (Fig.7.6b) has lead to the following inferences.

VILLAGE SILOKHRA
DISTRIBUTION OF CROPS
KHARIF CROPPING SEASON
1993-94

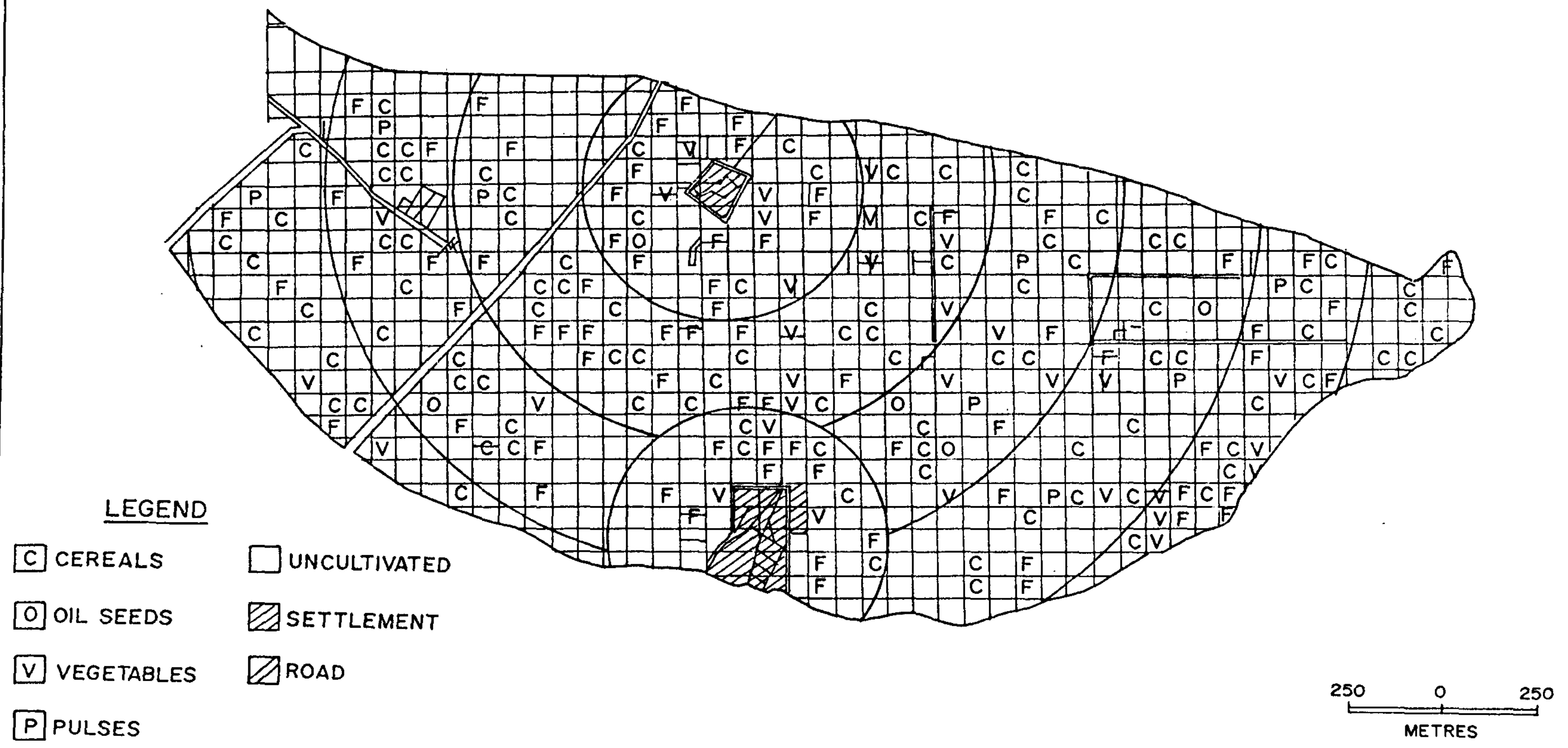


Fig.7.6a

VILLAGE SILOKHRA
DISTRIBUTION OF CROPS
RABI CROPPING SEASON
1993-94

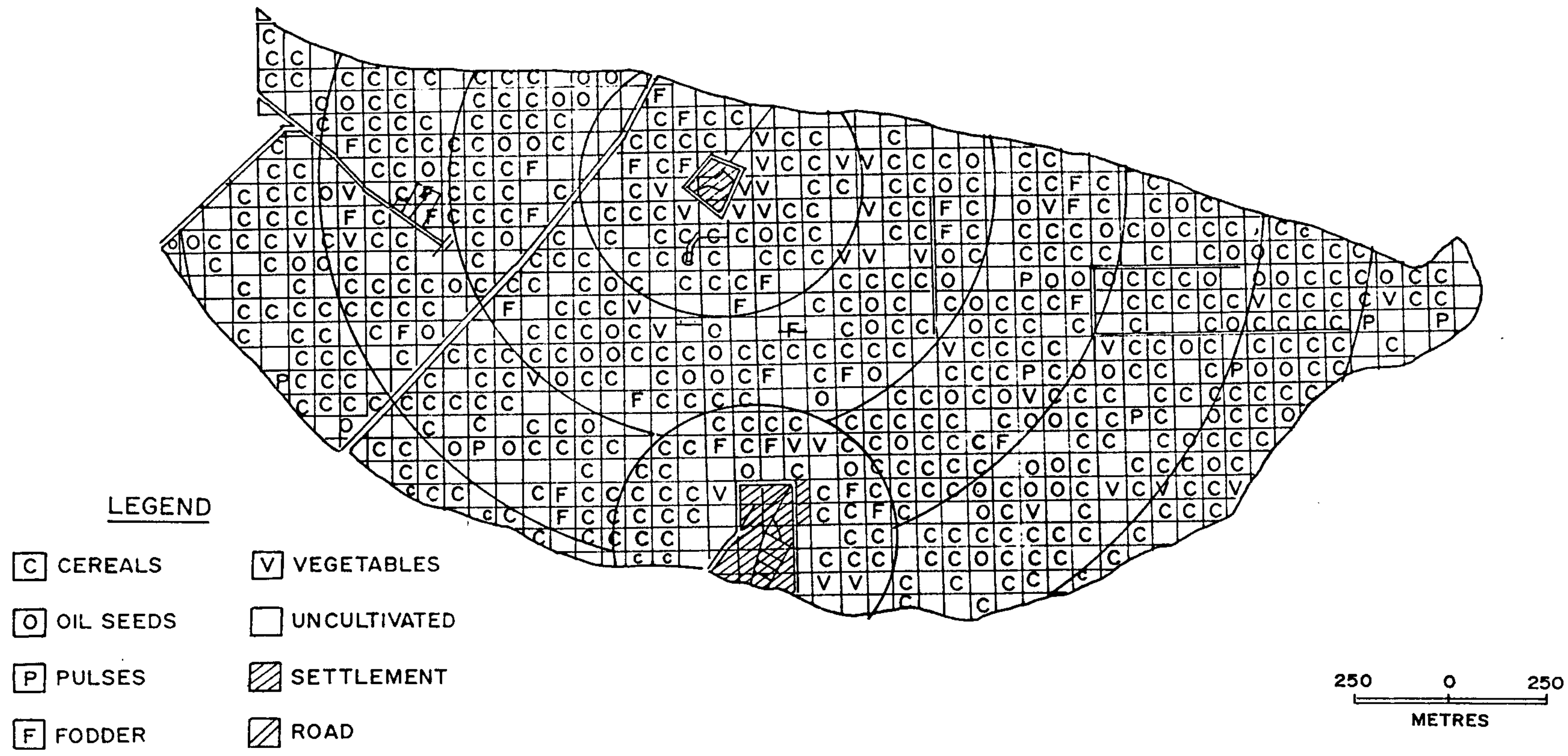


Fig.7.6b

(a) The cropping intensity and increasing distance from the village settlement

The examination of the graph (Fig.7.6.1A) reveals that there is a decreasing trend of cropping intensity with respect to increasing distance from the village settlement. The scatter plot (Fig.7.6.1B) along with least square line also exhibits the declining trend of cropping intensity with increasing distance from the village settlement. A very strong negative correlation of -0.92495 and a negative regression coefficient of -0.00019 further strengthens the above statement that there is an inverse relationship between the cropping intensity and distance of fields from the village settlement. Moreover, the coefficient of determination of 0.8555 indicates that 85.55 percent of spatial variation in the cropping intensity is explained alone by distance from the village settlement. The t-statistic of 4.8670 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is highly significant at less than 0.01 level of significance.

Hence, the hypothesis of an inverse relationship of cropping intensity and the distance from the village settlement is confirmed statistically with a high degree of confidence. This confirmation of the hypothesis is not much significant because in village Silokhara only 1.6% of the net sown area (4 hectares) is designated as double cropped area. This invites a question on the validity of this confirmation of hypothesis. In spite of very good irrigation facilities, the extremely low intensity of cropping is a consequence of the continuous process of large scale shifting of fertile agricultural lands to non-agricultural uses.

(b) The area under crops/crop groups and distance from the village settlement.

(i) Cereals (Kharif) - In village Silokhra during the Kharif cropping season of 1993-94 only two crops Jowar and Bajra were grown. Jowar occupied about 51.7% land while Bajra about 48.3% of the total area put under the cultivation of Kharif cereals.

The graphical record of the area under cereals of Kharif cropping season (Fig.7.6.2A) represents a steady increase with the increasing distance from the village settlement. The graph registers a slump in Zone-IV where the area has dropped to 8.1% as against 13.2% in Zone-III. The scatter plot along with the line of best fit (Fig.7.6.2B) also exhibits a continuous increase in the area under Kharif cereals with increasing distance from the village settlement. A strong positive correlation of 0.85875 and a positive regression coeffecient of 0.01278 statistically confirm this inference drawn from the analysis of the graph.

Further, the coefficient of determination of 0.7375 indicates that 73.75% of the spatial variation in the distribution of Kharif cereals is explained alone by distance from the village settlement. The t-statistic of 3.3519 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.05 level of significance. It implies that fit of regression analysis is quite reliable and there exists a strong relationship in reality. Hence, the hypothesis that area under cereals would increase with increasing distance from the village settlement is accepted in the case of Kharif cereals of Silokhra village. Kharif cereals like Jowar, Bajra are grown generally in arid and semi-arid climates and need small amount of inputs. Therefore, they are grown as a part of extensive agriculture.

(ii) **Cereals (Rabi)** - In village Silokhra during the Rabi cropping season only three cereals were grown. Wheat the most significant cereal has occupied 96.8%, barley the second in importance, has occupied 2.4%, and gram the third cereal, has occupied only 0.8% of the total area under the cultivation of Rabi cereals.

The graphical representation of the area under cereals of Rabi croppig season (Fig.7.6.3A) represents a confused and indefinite trend with increasing distance from the village settlement. It increases upto Zone-V with a slight slump in Zone-IV and a big drop in Zone-VI. The scatter plot with least square line (Fig.7.6.7B) also defines the same confused distribution of Rabi cereals in respect of increasing distance from the village settlement. A very weak negative correlation of -0.09754 along with a negative regression coefficient of -0.00217 further confirms that there exists no definite relationship between the distribution of Rabi cereals and increasing distance from the village settlement. This is further confirmed by the coefficient of determination of 0.00951 which indicates that merely 0.951% of the spatial variation in the distribution of Rabi cereals is explained by distance from the village settlement. The t-statistic of 0.19601 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant even at more than 0.05 level of significance.

Hence, the hypothesis that area under cereals would increase with increasing distance from the village settlement stands rejected in case of Silokhra village for want of strong statistical evidence. In view of high percentage of irrigated area it appears that cultivation of Rabi cereals is intensive, as a major part of them is occupied by wheat.

(iii) **Vegetables (Kharif)** - The line graph showing the distribution of vegetables of Kharif cropping season (Fig.7.6.2A) represents a general declining trend with respect to increasing distance from the village settlement. However, in Zone-V the area under vegetables (8.3%) is higher as compared to that in Zone-IV (1.6%). The scatter plot with the line of best fit (Fig.7.6.3B) also exhibits a slight declining trend in cultivated area under Kharif vegetables. However, the above statement is not a qualified statement in the light of correlation and regression statistics. A weak negative correlation of -0.39190 does not support the hypothesis while the coefficient of determination of 0.1535 indicates that only 15.35% of the spatial variation in distribution of Kharif vegetables is explained by distance from the village settlement. Further the t-statistic of 0.85194 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is insignificant at more than 0.05 level of significance. It implies that the distance from the village settlement is not a significant determinant of locational pattern of vegetables produced during Kharif in Silokhra.

Hence, the hypothesis that distribution of vegetables would decrease with increasing distance from the village settlement is not accepted for inadequate statistical support in the case of Silokhra village. It is perhaps on account of summer rains and better tube-well irrigation facilities and the market potential of big cities like Gurgaon and Delhi that a fairly good percentage of area is devoted to horticulture which ranks third after cereals and fodder invariably in every zone of production. The rejection of this proposition is pointing towards the significance of the influence of big cities in terms of high demand for vegetables which is translated in the form of increased locational distribution of Kharif vegetables even at the margins of cultivation.

(iv) **Vegetables (Rabi)** - The area under vegetables of Rabi cropping season shows no definite trend (Fig 7.6.4A) with respect to increasing distance from the village settlement. There is a rapid decrease in the percentage of area under vegetables upto Zone-IV, thereafter, it increases in Zones-V and VI. The scatter plot (Fig.7.6.8B) with least square line also represents the same confused trend of distribution of Rabi vegetables as correlation coefficient is as weak as -0.2667 and the coefficient of determination indicates that only 7.11% of the spatial variation in distribution of Rabi vegetables is explained by distance from the village settlement. The t-statistic of the regression coefficient (-0.00094) is worked out as 0.55322 which means that with 4 degrees of freedom the regression coefficient is insignificant at even more than 0.05 level of significance.

Hence, the hypothesis that area under vegetables decreases with increasing distance from the village settlement stands rejected in the case of Silokhra. Almost uniform provision of irrigation facilities together with excessive urban influence of Gurgaon and Delhi could be the basic reasons for this type of vegetables distribution.

(v) **Oil seeds (Kharif)** - The area under oil seeds of Kharif cropping season is confined to only Zone-II, Zone-III and Zone-IV. It shows an increasing trend (Fig.7.6.1A) upto Zone-III and then a decline afterwards with respect to increasing distance from the village settlement. The scatter plot (Fig.7.6.4B) with least square line also confirms that there exists no specific trend in the distribution of Kharif oilseeds with increasing distance from the village settlement. A weak negative correlation of -0.2764 suggests that the distance from the village settlement does not exercise any significant influence. Moreover, the coefficient of determination of 0.0764 indicates that only 7.64% of the spatial variation in distribution of Kharif oil seeds is explained by distance from the village settlement. The t-statistic of 0.57529 of the regression coefficient (-0.0002) with 4 degrees of freedom shows that the regression coefficient is insignificant even at 0.05 level of significance.

Hence, the hypothesis that area under oil seeds increases with increasing distance from the village settlement stands rejected in the case of Silokhra village. The reason for this may be that during Kharif season much emphasis is being placed on the cultivation of cereals, vegetable and fodder only. Oil seeds are given little emphasis and their area is confined to Zones-II, III, and IV only. Therefore, no strong trend of locational tendency of the oil seeds has emerged.

(vi) **Oil seeds (Rabi)** - The area under oil seeds of Rabi cropping season shows an average tendency of incerasing trend (Fig.7.6.3A) with respect to increasing distance from the village settlement. However, this trend is not clearly perceptible and is rather confusing. There is a slight decrease in the percentage of area under oil seeds in Zones-III and IV (9.0% and 6.5%) as compared to Zone-II (12.0%). The scatter plot (Fig.7.6.9B) with least square line also shows a moderate tendency of increasing trend in the distribution of Rabi oil seeds. A low positive correlation of 0.53713 reveals that the functional relationship between the two is not much significant. Moreover, the coefficient of determination is worked out as 0.2885 meaning thereby that only 28.85% of the spatial variation in the distribution of Rabi oil seeds is addressed by distance from the village settlement. The regression coefficient (0.003135) is also insignificant. Its t-statistic of 1.27358 with 4 degrees of freedom shows that the regression coefficient is not different from zero even at more than 0.05 level of significance.

Hence, the hypothesis that area under oil seeds increases with increasing distance from the village settlement stands unaccepted for want of proper statistical support in case of Silokhra. In fact Silokra which lies close to Delhi and very close to Gurgaon is witnessing a competition between the three crop groups viz. vegetables, oil seeds and fodder. All the three are grown directly or indirectly for commercial reasons. Farmer who is not a perfect economic man go for subjective decisions about the selection of crop's location out of the three crops mentioned above. The bidding of land, hence, becomes tilted more in favour of a particular crop group in every individual farmer's case. This defines why and how the present locational distributional trend of Rabi oil seeds is stablished in Silokhra.

(vii) **Fodder (Kharif)** - The area under fodder of Kharif cropping season shows a zig-zag trend with an average tendency of decline (Fig. 7.6.2A) with respect to increasing distance from the village settlement. From Zone-I to Zone-VI it is showing a sequence of decrease, decrease, decrease, increase and decrease. However, this trend is not clearly perceptible and is rather fuzzy in nature. The scatter plot (Fig.7.6.5B) with least square line also exhibits that there exists an average declining trend in the distribution of Kharif fodder with increasing distance from the village settlement. A weak negative correlation of -0.46029 shows anaverage but negligible tendency of the Kharif fodder to decline with the distance from the village settlement. This observation is further strengthened by a regression coefficient of -0.00358 whose t-statistic of 1.03695 suggests that with 4 degrees of freedom it is not different from zero. Moreover, the coefficient of determination of 0.2119 indicates that only 21.19% of the spatial variation in the distribution of Kharif fodder is explained by distance from the village settlement.

Therefore, the hypothesis that area under fodder crops increases with increasing distance from the village settlement is not accepted in case of Silokhra. Large scale shifting of landuse from agricultural to residential, commercial and industrial around Gurgaon city as a part of regional planning by the government agencies has created a profound impact on the locational patterns of crop landuse in the hinterland of Gurgaon city. However, much of the area which is devoted to the cultivation of fodder ranks first in Zones-I and II, and second in Zones-III, IV, V and VI states that farmers are putting much of their efforts in developing dairy industry, since there is a ready market for milk and high-value low-bulk milk products in Gurgaon city itself as well as near by Delhi. This has made farmers to grow fodder wherever suitable land is available with a strong tendency of concentration upon the land nearby the village settlement.

(viii) Fodder (Rabi) - The area under fodder of Rabi cropping season is showing a declining trend (Fig.7.6.4A) with respect to increasing distance from the village settlement. The scatter plot (Fig.7.6.10B) with least square line also confirms the statement of general declining trend in the distribution of Rabi fodder with increasing distance from the village settlement. A strong negative correlation of -0.94576 with a negative regression coefficient of -0.00395 further strengthens the above mentioned statement. Moreover, the coefficient of determination of 0.8945 indicates that 89.45% of the spatial variation in the distribution of Rabi fodder is explained alone by distance from the village settlement.

The t-statistic of 5.8225 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at more than 0.01 level of significance. It means that the proportionate distribution of Rabi fodder is real and is not due to chance.

Hence, the hypothesis that area under fodder increases with increasing distance from the village settlement stands unaccepted. The reasons are the same as stated in the case of Kharif fodder. However, a fairly good percentage of area put to the cultivation of fodder confirms that there are some economic considerations involved in the production of fodder in Silokhra. The fodder has emerged an important crop in the economy of this village therefore, it occupies prime land even in the vicinity of the village settlement.

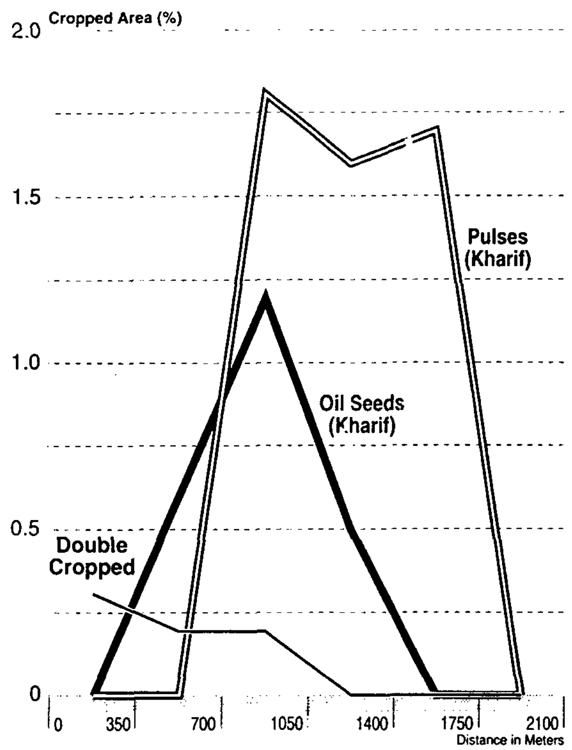
(ix) **Pulses (Kharif)** - The area under pulses of Kharif cropping season is confined to only Zones-II, III, IV and V. It is showing a very confused trend (Fig.7.6.1A) with respect to increasing distance from the village settlemnt. There is a steep rise from 0.0% in Zone-I to 1.8% in Zone-II, and then a slight decline to 1.6% in Zone-III which is followed by a slight increase to 1.7% in Zone-V. The scatter plot (Fig.7.6.6B) with least square line though exhibits a rising trend in the distribution of fodder, yet it is not supported by the correlation and regression statistics. A weak positive correlation of 0.28064 with a positive regression coefficient of 0.00040 states that there exists no strong relationship between the distribution of pulses and increasing distance from the village settlement. Moreover, the coefficient of determination of 0.0788 indicates that only 7.88% of the spatial variation in the distribution of Kharif pulses is explained by distance from the village settlement. The t-statistic of 0.5848 of the regression coefficient with 4 degrees of freedom shows that the regression coeffecient is insignificant both at 0.01 and 0.05 level of significance. It implies that the observed increase in the distribution of Kharif pulses is not real and is due to chance only.

Hence, the hypothesis that area under pulses would increase with increasing distance from the village settlement stands rejected in the case of Silokhra. The reasons are shifting of landuse more in favour of urban uses, and shifting of interests of farmers much towards non-agricultural ones, as well as pulses being less preferred crops almost throughout Gurgaon district, are not placed much significance for being cultivated in Silokhra during Kharif cropping season.

(x) **Pulses (Rabi)** - The area under pulses of Rabi cropping season shows a rising trend (Fig.7.6.3A) with respect to increasing distance from the village settlement. However, there is a slight decrease in the percentage of area in Zone-IV (1.1%) as compared to Zone-III where the area under pulses is 1.8%. The scatter plot (Fig.7.6.11B) with least square line also exhibits a general rising trend in the distribution of Rabi pulses with increasing distance from the village settlement. A very strong positive correlation of 0.09351 with a positive regression

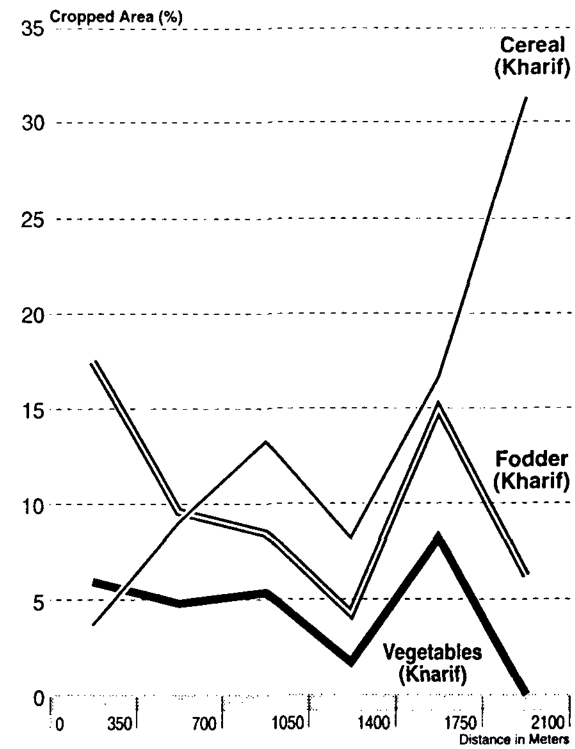
Village: Silokhra **1A**

Distribution of Crops/Cropping Intensity
Gurgaon (Gurgaon)
1993-94



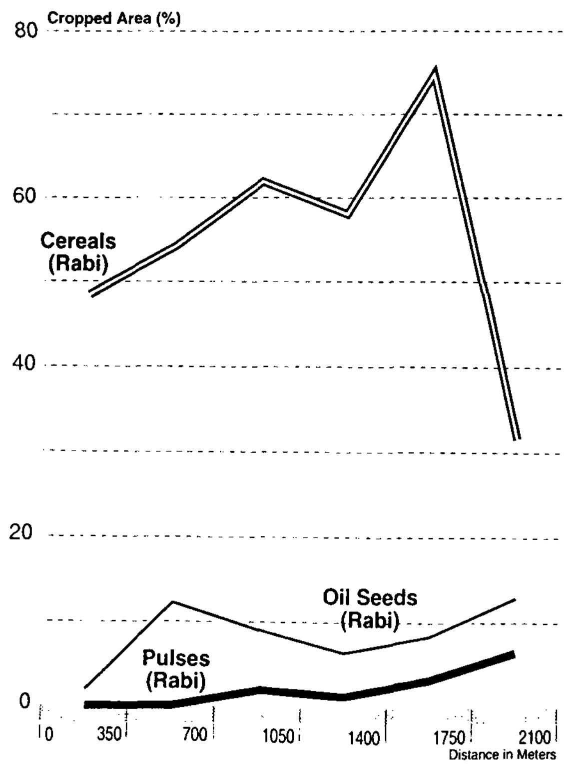
Village: Silokhra **2A**

Distribution of Crops/Cropping Intensity
Gurgaon (Gurgaon)
1993-94



Village: Silokhra **3A**

Distribution of Crops/Cropping Intensity
Gurgaon (Gurgaon)
1993-94



Village: Silokhra **4A**

Distribution of Crops/Cropping Intensity
Gurgaon (Gurgaon)
1993-94

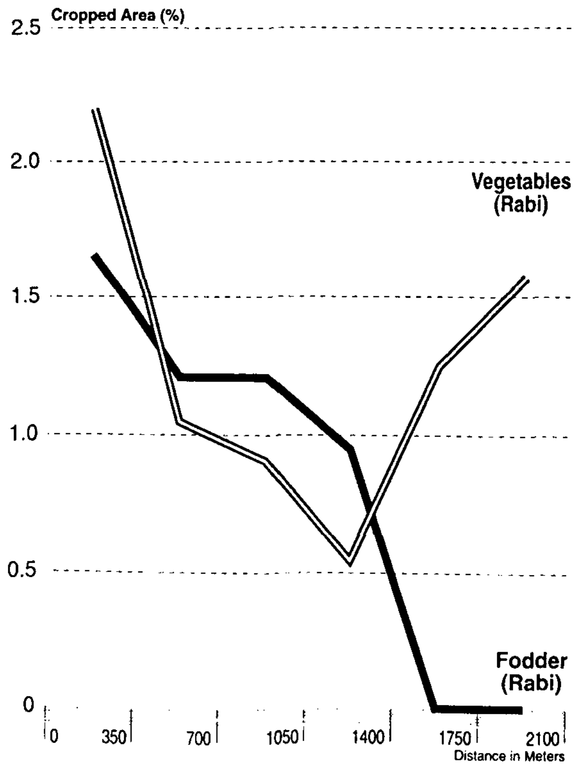


Fig. 7.6

Village Silokhra

Locational Patterns of Cropping Around Village Settlements

(1993-94)

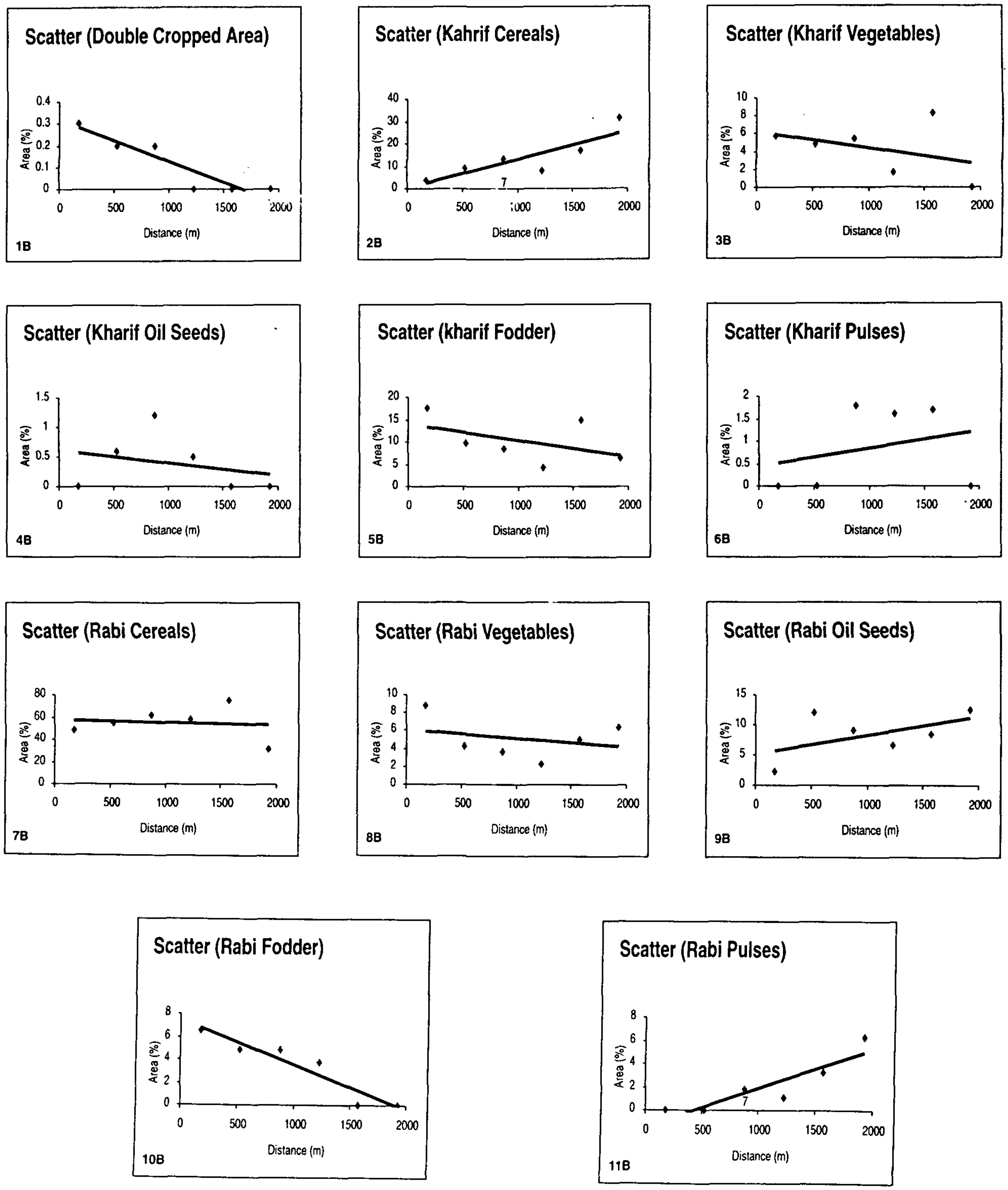


Fig. 7.6

coefficient of 0.00332 further supports the above mentioned statement. Moreover, the coefficient of determination of 0.8164 indicates that 81.64% of the spatial variation in the distribution of Rabi pulses is explained alone by distance from the village settlement. The t-statistic of 4.21744 of the regression coefficient with 4 degrees of freedom shows that the regression coefficient is significant at less than 0.01 level of significance. It implies that the proportionate increase in the area of Rabi pulses with increasing distance from the village settlement is real.

Hence, the hypothesis that area under pulses increases with increasing distance from the village settlement is confirmed in the case of Silokhra. The statistical confirmation of hypothesis regarding the distribution of pulses in Rabi cropping season may be treated as an exception, since in all the six sampled villages, it is the only village where the distribution of pulses lies is conformity with the hypothesis. The probable reason for the confirmation of this hypothesis is great demand for pulses like lentil, Tur and gram in the markets of Delhi and Gurgaon. The allocation of more area to the cultivation of pulses in the outer zones of production is, therefore, on account of the factor of demand and not due to the extensification of cultivation.

Concluding the findings of this village Silokhra, it may be stated that under the influence of tube-well irrigation and urban influence of big cities like Gurgaon and Delhi, the hypotheses formulated came true only in respect of intenstiy of cropping, Kharif cereals, Rabi oil seeds, Rabi fodder and Rabi pulses. The hypotheses regarding other crops/crop groups are not confirmed.

The results of this chapter are given in consolidated form in Appendix-XIII which summarises the statistical testing of the hypotheses at micro-level formed under the assumptions of alternative model of agricultural landuse. It is a hard fact that most of the propositions stand rejected. The number of such propositions is 43 out of 66. A further breakup of this figure of 43 states that 13 (20%) of the hypotheses are rejected on solid statistical ground, while 17 (26%) are showing a favour to the formulated hypotheses but they are not accepted for the lack of adequate statistical support, and on similar ground 13 (20%) are not accepted for their opposite trend. In 17 (26%) cases the tested hypotheses are accepted with fully required statistical support. In the remaining 6 (9%) cases for paucity of data the formulated hypotheses are not tested.

The main findings of this chapter are given below.

1. The intensity of cropping at village level decreases with increasing distance from the village settlement. This statement is found true in all selected villages except in the case of Sewka which could be treated as an exception, since the present study is based upon only one point of time. This finding lies in conformity with that of Thunen's proposition of decreasing cropping intensity with increasing distance from the settlement.

2. The area under cereal crops would increase with increasing distance from the village settlement. For Kharif cereals this statement is found true only for Sewka and Silokhra villages, both having about 90% of area irrigated by tube-wells. However, Karamchandpur an exception, where 100% area is irrigated by canals, does not confirm this statement. The villages which are having a rainfed agriculture like Gumat Bihari, Balola and Iqbalpur show a decrease in the area under Kharif cereals with increasing distance from the village settlement. In these villages which greatly depend upon rainfall for agriculture, the area under Rabi cereals also decreases with increasing distance from the village settlement. In villages with assured water supply like Sewka and Karamchandpur the locational distribution of Rabi cereals increases, however, their is one exception of village Silokhra in this respect where inspite of 91.63% irrigated area there is a decline in the acreage of Rabi cereals with increasing distance from the village settlement.

3. The area under vegetables would decrease with increasing distance from the village settlement. This statement is found true for both Rabi and Kharif vegetables, with only two exceptions. Area under Rabi vegetabels of village Iqbalpur is one of the exceptions. The other exception is village Silokhra in which area under vegetables in both Rabi and Kharif cropping seasons increases with increasing distance from the village settlements. In fact it is the proximity to the source of irrigation that has reversed the excepted locational pattern of vegetables in these two villages. However, in case of the majority of villages the area under

vegetables lies in conformity with that of Thunen's proposition that, area under vegetables (horticulture) would decrease with increasing distance from the settlement. However, a slight modification to this proposition is observed in those areas which are subjected to great population pressure from near by big market places. Such areas defy Thunen's proposition and go for horticulture even at great distanses from the village settlement.

4. It is hypothesised that locational distribution of oil seeds of both Rabi and Kharif seasons would increase with increasing distance from the settlement. This hypothesis is not found true for both Rabi and Kharif oil seed crops. The exception in this regard is observed in Karamchandpur village. In Karamchandpur during Rabi season only, the area under oil seeds has recorded an increase with increasing distance from the village settlement. This conformity with the Thunen's proposition may be due to sampling error.

5. The hypothesis that the area under fodder crops of both Rabi and Kharif cropping seasons would increase with increasing distance from the village settlement is not true in almost all the six villages. Iqbalpur is the only exception, where distribution of Kharif fodder is showing an increasing trend with distance. It is due to better tube-well irrigation facilities in Zone-V as well as better road accessibility. In Silokhra the area under Kharif fodder crops does not show a strong relationship with increasing distance from the village settlement despite large concentration of this crop in the Kharif season.

The hypothesis that locational distribution of pulses of Rabi and Kharif would increase with distance from the village settlement does not hold good either for their opposite trend or, for want of statistical support. The case of Silokhra village is an exception where pulses mainly of Rabi exhibit strong relationship between their location and distance from the village settlement.

From the above findings it comes out that derivations from the Thunen's model do not conform well with the realities of the agriculture. In fact, importance of crops in agricultural economy of the rural population is dictated by cultural and environmental possibilities and constraints. These play a dominant role in defining economic rent which ultimately lies under the decision making regarding location of crops on the village space.

District Gurgaon is a semi-arid area where agriculture in vast areas particularly in southern part is mostly rainfed. In such conditions the cereal crops taxing less on water resources, are most favoured. Crops like wheat in Rabi can be grown in areas where assured water supply is available. Obviously, this situation makes cereals very important in the agricultural economy of the region where commercial farming of vegetables, sugarcane etc. is restricted by the total absence or inadequacy of irrigation. This has resulted in the allocation of good quality land under cereals, as the total agricultural economy is extensive in large part.

Another point that needs clarification is the fact that in dry conditions of the region high remunerative crops like wheat and paddy can not be raised on large scale. This statement is true mainly for the southern part of the district where sub-soil water is also not suitable for irrigation in vast areas. Therefore, dairying has emerged as an important component of the agricultural economy. Besides the people living in this area are traditionally known for animal husbandry. Thus, culture and environmental possibilities with nearness to a large milk market of Delhi and Gurgaon all have made dairying and consequently fodder crops in the cropping pattern of the region very important. Obviously, the land thought to be good is allocated to fodder crops and it emerges as intensive rather than extensive cultivation. This explains why the hypotheses regarding fodder crops under the postulates of the model is not confirmed.

Like cereals, oilseeds show that they are also important in the agricultural economy of the villages of Gurgaon. As mentioned above, in dry conditions of the region where choice is restricted to a few drought resisting crops, oilseeds demanding less water become important. In the overall extensive farming they also occupy good land. However, when situation changes, that is, irrigation is made available, these crop show a relatively less important place as far as location of crops on village space is concerned.

Pulses also show that they are important crops, and particularly in Rabi season they are grown on sufficiently large areas. However, they are mostly grown for home consumption. The commercial farming of pulses is, however, observed around cities like

Gurgaon and Nuh, where the trend of their distribution is opposite to that which is hypothesised.

This study partially confirms Von Thunen's model. It shows that environment and culture define importance and preferences regarding crops in the village economy. Crops defined important in terms of transport cost and market value cannot be grown due to constraints imposed by environment. Similarly, cultural practices also determine crop preferences of group of people. Therefore, when formulating hypotheses in the ambit of von thunen's model one has to look into the importance of the crops in the local economy and society rather than their place in the national and international market. Thus, von thunen's model should be modified according to local conditions. However, its explanatory power as a base model of landuse can not be undermined.

So, in the nut shell it can be said that Thunen's model in its original form in the study area is not aplicable in totality. However, it holds good partially for cropping intensity and vegetables at village scale.

CONCLUSION

Farming for cash income or subsistence or both is to support a farmer and his family economically which means that his produce must be either used by him or sold or exchanged in the market. This is not implicit that economic principles are always uppermost. The impact of ever changing patterns of demand, supply, prices, government policies, and subsidy structures are of considerable significance.

The physical environment which does not act in a deterministic manner, lays down broad controls over what would and what would not be grown, moreover, it also controls yield, which is expected from the given doses of inputs of labour, fertilizers, and other factors of production. Economic and physical factors interacting with each other in a complex manner together with certain characteristics of the farmer himself, establish a range of possible forms of production, one or more of which may be chosen. To some extent the range of choice offered by the physical environment can be extended by factors of the economic environment .Investment, in the form of private capital or government assistance,can be substituted for less ideal environmental conditions.

The present study was aimed at examining the existing locational patterns of crop landuse in Gurgaon District from the angle of agricultural landuse location model put forward by J.H. Von Thunen in 1826. The model is *an economic translation of cropping patterns in terms of their* location with respect to increasing distance from a market place subject to given laboratory conditions. The problems and challenges of agricultural practices of the modern times are different from those then existing in

1826. However, the basic theme and foundation provided by the Thunen's model still commands the respect as it did till late 1950s.

If on one hand in modern times it is very difficult to come across an 'Isolated State', then it is also a challenging task to make a successful effort in searching out a conclusion strictly in the light of Thunen's model which would remain valid for the same study area for times to come.

Unlike Thunonian times, when 'isolated states' were not uncommon and when transportation cost was the only determinant of crop location and economic rent, in the present day agricultural scenario, there is a whole gamut of physical, economic, cultural, tecnological, political, fiscal and institutional factors which are interacting with each other in a very complex manner in defining the location of crops. In the absence of isotropism, the patterns of dispersal of crops and cropping intensity, both are subjected to frequent variations over time and space, in accordance with the necessities and inventions.

The district of Gurgaon is a part of Southern Haryana Plain. The facts associated with the district of Gurgaon are that, about 7 % of the geographical area is falling under the category of rocky outcrops which are barren hills with very small vegetative cover.It experiences a semi-arid, sub-tropical, continental type of climate, with no prominent drainage system. The hydrology of the district both in terms of depth and quality of sub-soil water is also not very conducive. Vast areas of southern and south-western parts of the district including Nuh, Nagina, and Punhana blocks carry sub-soil water which is saline and is not much suitable for irrigation. At places the water-table is deeper than 25 meters, however, there are areas where the depth of water is about 2 meters only. The depth of water-table is increasing at an average rate of 0.35 metres/year for the reason of over exploitation of ground water resources . The number of minor irrigation units (tube-wells) have increased from 5278 (1966-67) to 33304 (1992-93). Hence, tube-well irrigation with its share of 81.40% is playing well in the development of agriculture of the district. Canal irrigation accounts only for about 11.09% as per 1991 records. The soils in the area belong to Quarternary alluvium and Pre-Cambriam mata-sediments of Delhi system which vary from loamy to sandy loam in texture with low to very low organic carbon contents. About 64% of the area is net sown area with another about 15% which is designated as current fallow, the rest of the area is not available for agriculture. Cereals dominate agricultural landscape in both Kharif (96.81%) and Rabi (63.82%) cropping seasons. To the south of Sohna the countryside is inhabited by a moslem community of Meos which are the natives of this part for centuries. North of Sohna is inhabited mainly by Jats and also by Punjabi migrants to some extent. The district has good network of roads and is well connected to other parts of the state, as well as, to the rest of the country. A good number of people commute between their homes and cities like Gurgaon and Delhi etc., on daily/weekly and monthly basis.

So the lack of isotropism in study area is observed. The efficient movement of goods and people has promoted diffusion of knowledge and has helped intermixing of rural economy. Because of the semi-arid climatic conditions and much reliance upon summer rainfall specially in greater parts of southern Gurgaon, a semi-subsistence type of agriculture is developed where majority of the farmers are not indulged in overtaxing upon soil resources.

Besides the lack of isotropism in the study area, the other limitation is about the quality of data. The data were collected for only one point of time (1993-94). Had they were been collected for at least three successive points of time, and then averaged out, there could be a better understanding of the research problem. However, besides all above mentioned limitations the findings are interesting.

The results collected out of all the seven zoning schemes at macro-level, as well as those of all the six villages ie. micro-level study are summarised below.

The postulated inverse relationship of cropping intensity with increasing distance from the two urban centres of Gurgaon and Nuh is confirmed statistically as non-existing. However, this observation has a marked differenciation. Unlike Nuh, in case of Gurgaon, the hinterland is reeling under great population pressure from Gurgaon (a class-II city, Census of India, 1991) itself, as well as, that from Delhi which lies only twenty-five kilometers away from Gurgaon city. The district of Gurgaon shares a common border with Delhi state. Hence, in case of Gurgaon the apparent trend of cropping intensity, which is statistically not proved true, is showing a positive relationship with distance, a condition which is justified but is opposite to that perceived under the postulate. Another important reason for this type of trend of cropping intensity is the allocation of land in the immediate vicinity of Gurgaon city to various developmental sectors by the Government of Haryana, with a motive of regional development. This has rendered most of the fertile neighbouring agricultural fields either totally unused or partially used for cultivation. In other words these fields are ploughed once a year generally in Rabi season. Thus, the percentage of double cropped area in the immediate neighbourhood of Gurgaon instead of being higher is comparatively lower than that in other zones of production. A model presented by Sinclair seems to be operative. In case of Nuh (a class-V town, Census of India, 1991) with a little population pressure, the intensity of cropping in its hinterland seems to lie in conformity with the formulated hypothesis. However, this apparent trend of declining cropping intensity around a small town like Nuh, could not be proved true on statistical grounds.

The relationship between cropping intensity and the distance from the lines of communication, the Delhi-Jaipur Railway and the Delhi-Alwar highway (Nuh-Nagina Part), exhibits rejection of the postulate for want of adequate statistical support. The apparent relationship of cropping intensity and distance from the railway seems to lie in line with that of respective proposition, however, on account of greater flexibility of road transportation, the gradient of cropping intensity from the road is against the presumption. This tells about, that the gradient of cropping intensity is steeper from railway rather than road. The other fact which is associated with this segment of the road (Nuh-Nagina Part) is that, it passes through a region where in vast areas, sub-soil water is subjected to hyper-salinity. It consequently makes irrigation less effective, and thus, making the present trend of cropping intensity more doubtful to believe.

The distance from the canal and cropping intensity, is having an inverse mutual relationship which also is not statistically verified true. The main reason may be that, Patakpur Minor Distributary of Gurgaon Canal is not a perennial source of water supply. During pre-monsoon period it is a dry channel with intermittent pools of water. This explains why distance from canal is statistically not much effective in defining the declining trend of cropping intensity.

The intensity of tube-well irrigation in angular zones about both Shona and Nagina shows a sound positive affinity with intensity of cropping which is also statistically well supported. It is, therefore, argued that cropping intensity behaves accordingly with the postulation only in the case of tube-well irrigation in angular zones about Sohna and Nagina.

At micro-level, the study of cropping intensity reveals that under semi-arid rainfed agricultural conditions like those of Gumat Bihari, Balola and Iqbalpur the proposition of decreasing intensity with increasing distance from the village settlement is proved true on solid statistical grounds. In villages with assured irrigation like Karamchandpur and Silokhra as well as Sewka the cropping intensity decreases with distance from the village settlement.

It is, therefore, concluded that as regional scale cropping intensity is significantly affected by the provision of irrigation facilities in most of the cases. However, in case of hinterlands of big urban centres, on account of great population pressure the reverse may be true.

The distribution of cereals reveals that, at macro-level in case of Kharif cereals like Jowar and Bajra which are the crops of dry farming, the laid down hypothesis is statistically verified true only in case of road accessibility (Appendix-XIII).

It refers to, that decreasing accessibility, particularly road accessibility has a bearing on extensification of cereals, through the available doses of inputs which are also affected by increasing distance from the lines of communication. In case of distance from urban centers, the trend, though statistically not sound, yet, it is falling in line with the supposition of increasing extensification with increasing distance from the market places. In case of distance from canal or increasing tube-well irrigation in zones about Sohna and Nagina the trend of Kharif cereals is opposite to that presumed.

It is concluded that Kharif cereals which are less water demanding crops the rising trend of their distribution is due to real extensification in respect of increasing distance from urban centers and the lines of communication, with railway an exception. In respect of canal and tube-well irrigation a positive trend of the locational distribution of Kharif cereals reveals that in semi-aried climate with low reliablity of rainfall, irrigation is important even for Kharif cereals.

The distribution of Rabi cereals is showing a tendency of conformity with the postulate in all zoning schemes except in case of angular zones about Sohna, where an inverse trend is observed. The statistically positive trend is seen only in zoning scheme around Gurgaon, where the hinterland is under great population pressure of Gurgaon and Delhi. A positive trend in the zoning schemes along railway and higway is perhaps due to good tube-well/canal irrigation facilities, that the distribution of Rabi cereals has fallen in conformity with the proposition. Wheat the main dominant Rabi cereal crop, is also a staple diet of the peopole of study area. Its high yielding varieties require at least four waterings during its field life, therefore, at macro-level it is argued that, the distribution of Rabi cereals is influenced primarily by the availability of water and then by the factor of demand which is generated by population size of the neighbouring cities, which in turn help in arousing commercial and economic motives among the farmers.

At micro-level particularly in villages which greatly bank upon rainfall for agriculture, the distribution of Kharif cereals is showing a trend opposite to what is perceived in hypothesis. However, the villages with assured water supply like Sewka and Silokhra are showing a direct relationship of Kharif cereals with increasing distance from the village settlement. Karamchandpur a village with canal irrigation is showing exceptionally a negative trend of distribution which is not proved true on statistical ground. This explains that irrigation for Kharif cereals too is much significant for their locational distribution at village scale. The distribution of Rabi cereals in villages with rain-fed agriculture shows a statistically confirmed declining trend, a tendency which is not in conformity with the postulate. However, in Gumat Bihari, this trend is positive with a weak statistical support. In villages with assured water supply like Sewka and Karamchandpur the trend of Rabi cereals, distribution is alike to that presumed. However, in village Silokhra which also has a good irrigation facilities a statistically unconfirmed opposite trend is observed, which is explaind by large scale transfer of good agricultural land to non-agricultural uses around Gurgaon city by the Government of Haryana. Silokhra only two kilometers away from Gurgaon is also under the transitional period of transformation.

It may, therefore, be concluded that at village scale, strictly under rainfed condition both in Kharif and Rabi cropping seasons the extensification of cereals is not possible and their acreage declines with increasing distance from the village settlement. However, if assured water supply is there, then outward from the village settlement an increased locational distribution of both Kharif and Rabi cereals is observed. This situation explains how, spatial variability of rainfall is counter balanced by the provision of irrigation facilities.

The analysis of the distribution of vegetables in Kharif and Rabi at macro-level states that vegetables are truely following the Von Thunen's proposition of decreasing distribution with inceasing distance from the market places, the lines of communication, the canal, and the tube-well irrigation. In most of the cases the formulaed hypotheses are proved true on valid statistical grounds, however, in few cases a trend in conformity with hypotheses but with a weak statistical support is seen (Appendix-XIII). Only two cases i.e. Kharif vegetables in case of road accessibility and Rabi vegetables in case of angular zoning about Nagina, show a trend which is opposite to that perceived in the formulated hyposthesis. At micro-level the distribution of vegetables is comparatively more transparent and is lying completely in conformity with the respective proposition of declining trend with increasing distance from the village settlement. In most of the cases the results are statistically valid while in other cases the distribution of vegetables, though, lying in conformity with the hypothesis is not proved true on solid statistical grounds. In both types of villages with a dominant rainfed as well as a dominant irrigated agriculture, vegetables distribution decreases with distance from the village settlement irrespective of that the villages are under the direct influence of a small urban settlement like Nagina (Village Gumat Bihari), simply a village settlement (Village Balola), roads (Village Iqbalpur), tube-well irrigation (Village Sewka), canal irrigation (Village

Karamchandpur), or a combined effect of tube-well irrigation as well as big urban settlements like Gurgaon and Delhi (Village Silokhra). In case of Silokhra and Iqbalpur the gradient of vegetables distribution is not as steep as to be verified true statistically. This tells about much demand and large urban influence of Gurgaon in Delhi in case of Silokhra. In Iqbalpur the influence of a small township Farrukhnagar which is just five kilometers from the village is generating more demand for vegetables which makes horticulture a more profitable business in this village. Moreover, much area under vegetables in outer zones of Iqbalpur is perhaps because of better tube-well irrigation facilities, as well as, nearness to a road in the outer zones of production. This explains why the horticulture in these two villages does not show a steep declining trend.

Vegetable fields require frequent visits for the sake of protection from stray animals and also because vegetables are perishable products and that they need more water for being grown, a ready màrket and efficient transportation therefore, the locational distribution of vegetables is negatively related with distance from the market places, lines of communication and sources of irrigation both at regional as well as village scales. Another factor which is also an important factor in the location of vegetables is socio-cultural setup of the study area. In study area vegetables cultivation is considered as an inferior enterprise associated with a particular group of people known as Sainis who specialise in vegetable cultivation. The other village community of Zamindars avoide growing vegetables. However, slow change and diffusion of vegetable cultivation is now seen in Zamindars as well.

The cultivation of oil seed crops in both Rabi and Kharif would show an increasing trend of distribution with distance from urban centres, lines of communication and canal. This was presumed because oil seed crops are less input intensive and less water demanding. On regional scale in case of both urban settlements Gurgaon and Nuh this presumption is found invalid on statistical ground, however, the distribution of oil seeds in both cropping season is lying in conformity with the presumption. The difference lies in absolute distribution of oil seeds in the cropping seasons of Rabi and Kharif. During Kharif the total area put to the cultivation of oil seeds is far smaller than that put under Rabi season. It tells about, that Rabi oil seeds are cultivated with a definite economic and commercial motives. Rabi oil seeds (primarily rape seed and mustard) provide a major shere of edible oil widely used as a cooking medium and is always in great demand in the study area.

The impact of accessibility on the distribution of oil seeds is also not established in the spirit of formulated hypothesis. In general there is a reverse trend which is statistically insignificant.

The hypothetical perception of increasing distribution of oil seeds with increasing distance from the canal is also not proved true statistically. Moreover, it shows a trend which is inverse to that of presumption. In case of tube-well irrigation, the acreage under oil seeds of both Kharif and Rabi shows a statistically weak tendency in accordance with formulated hypothesis. The only exception is that of Kharif oil seeds in case of angular zones about Nagina, where a statistically valid positive trend of locational distribution of oil seeds is observed.

It is, therefore, generalised that at macro-level distribution of oil seeds lies in in conformity with the postulations in respect of increasing distance from the market places and irrigation intensity. The lines of communication and distance from the Patakpur Minor Canal (a seasonal canal) have little impact on the location of oil seed crops on regional scale.

At micro-level in the villages Gumat Bihari, Balola and Iqbalpur which offer rainfed agriculture, Kharif oil seeds are not cultivated, and Rabi oil seeds are the second, first and second ranking crops respectively. It appears that when the climate is harsh and irrigation facilities are not well developed, the acreage under oil seeds decreases in response to increasing distance from the village settlement, irrespective of that, whether the village is under the influence of a big Mandi - the market (Village Gumat Bihari), or it is having a good accessibility (Village Iqbalpur), or it is just under the influence of rainfed agriculture (Village Balola). The other three villages namely Sewka, Karamchandpur, and Silokhra which are having good tube-well/canal irrigation facilities exhibit a tendency of the distribution of oil seeds which in general (mainly of Rabi oil seeds) seems to lie in conformity with the respective proposition. Irrespective of uniform irrigation facilities that are present in these three villages an apparent extensification of oil seeds with distance from the village settlement states that it is not an extensification in the real sense of the term, but, it is a case of greater concentration of these crops with almost same input-output ratio. On account of assured irrigation, farmers have a range of choices for the crops to be grown, therefore, oil seeds in these three villages show an absolute distribution (Appendix-XI) which ranks between III and V among all crops groups. However, high market value of Rabi oil seeds is a strong instinct to which the farmers react. Therefore, in case of oil seeds of both cropping seasons specially those of Rabi, market price is the sole economic motive which controls the dicision making of the farmers and the location of oil seeds over the village space.

At macro-level fodder distribution in both Kharif and Rabi cropping seasons, in all the seven zoning schemes, in nine out of fourteen cases, show a decreasing trend of distribution with increasing distance from urban centres, lines of communications, canal and intensity of tube-well irrigation. Out of these nine cases, five were proved true on firm statistical grounds. This tendency of distribution points towards the reasons of decreasing demand of dairy products with increasing distance, and consequently for fodder which is a low-value high-bulk product for which it becomes uneconomic to be produced at greater distances from the source of consumption. In absolute terms more acreage allocated to fodder crops in the inner zones of production reveals that commercial dairy farming is practiced around Gurgaon and Nuh. From the lines of communication the decreasing attitude of fodder distribution reveals that with increasing distance ie. decreasing accessibility, the distribution of fodder also decreases. Here is the economics of the transport cost which comes forth in defining the locational distribution of fodder crops.

In case of Patakpur Minor Distributary of Guraon Canal, the locational trend of fodder crops shows an increase and decrease in Kharif and Rabi seasons respectively, which lies in conformity with respective postulate only in case of Kharif fodder. The canal, is not a perennial source of water. Therefore, cropping of fodder is more dependent upon irrigation in Rabi and shows an inverse relationship (statistically not sound) with distance from the canal.

In case of angular zones about Sohna and Nagina the trend of fodder distribution as observed seems opposite to that which is hypothesised ie. it shows an apparent increasing trend with incresed irrigation intensity, except in case of Rabi fodder in angular zones about Nagina. It refers to a positive relationship between the irrigation intensity and acreage of fodder crops in the study area. In a semi-arid climatic conditions the restrictions imposed by nature on the choice and diversity of cropping are severe. After cereals and oil seeds, the promotion of animal husbandry has in turn promoted fodder cultivation. This describes greater allocation of area to fodder crops in inner as well as outer zones of production at macro-scale.

On village scale it was assumed that, the trend of fodder distribution would rise with distance from the village settlement for reasons of its low-value and high-bulk nature, as well as, having a less input demanding character. In all six sampled villages for both Kharif and Rabi cropping seasons, out of twelve in eleven cases, the recorded evidence is against the postulate. Among these eleven cases six are having sound statistical backup. The Rabi fodder distribution of village Iqbalpur is a typical case where road accessibility is better for outer than inner zones of production. Consequently the dairy industry has developed in outer parts of the village. So, it is generalised that, at village scale, irrespective of the level of irrigation intensity, the locational distribution of fodder crops in both Kharif and Rabi seasons, is inversely related to distance from the village settlement.

In case of pulses, the formulated hypothesis states that area under pulses would increase with increasing distance from the urban centres. It means that pulses which are less water demanding should express a character of extensive farming and they should occupy less fertile lands away from the settlements. The distribution of pulses around Gurgaon and Nuh could not be proved true in accordance with the laid down hypothesis. Around Gurgaon the area under pulses in both Rabi and Kharif cropping seasons instead of showing an increase, is showing a downward slope. This explains, that the status of pulses in the economy of this part of the study area is significant, and therefore, they are grown intensively rather than extensively. In both seasons they occupy fairly large area even in the inner zones of production around Gurgaon. The high demand of pulses in the markets of Gurgaon and nearby Delhi provides a justification for this type of locational distribution of pulses around Gurgaon.

More or less the same condition is prevailing around Nuh with a difference that in this case the departure from the formulated hypothesis, is not verified correct statistically. The other difference is that the total area in terms of percentage put to the cultivation of pulses around Nuh is smaller than that around Gurgaon. This is mostly because Nuh which is a small township generates lesser demand for pulses on one hand, and on the other hand being farther from Delhi than Gurgaon, a lesser influence of Delhi on the cultivation of pulses around Nuh is felt. Therefore, if it is stated that distance from the urban centres is promoting intensification of pulses, it would not be a valid statement. It is the economics of demand which defines locational distribution of pulses.

The distribution of pulses along the railway was not recorded in Rabi seasons in the sampled villages in zones along the railway, and only a meagre presence during Kharif in zones-I and II (0.31% and 0.41% respectively) though recorded, was not analysed for the purpose of hypothesis testing.

In case of distribution of pulses along highway the hypothesis is proved valid for Kharif pulses. A statistically weak negative trend of distribution is observed for Rabi pulses. It is, therefore, generalised that the lines of communication and the distribution of pulses have a fuzzy relationship.

The distribution of pulses with respect to intensity of irrigation shows that both increasing and decreasing trends are not proved true statistically. In Kharif, irrigation has little role to play in the cultivation of crops like pulses which require less amount of water. The distribution of pulses during Rabi, therefore, is considered more reliable for testing the hypothesis. In case of canal irrigation, and irrigation by tube-wells about Nagina, the distribution of pulses show an extensification which is attributed to limited irrigation facilities in both cases. The canal is a seasonal distributary, while about Nagina tube-well irrigation is not well developed for the reason of brackish sub-soil water in vast areas. However, in case of tube-well irrigation about Sohna there exists an apparent positive relationship between the intensity of tube-well irrigation and the distribution of pulses, which is also having a weak statistical backup. It is therefore, infered that pulses which are grown in small quantities mainly for home consumption do not shows any particular trend of distribution, since they suffer from high degree of subjectivity in decision making of the farmers regarding their location. However, around big urban centres economically motivated intensive cropping of pulses is not seen uncommon where pulses outbid other crops in the inner zones of production.

At micro-level in those villages which are having a rainfall dependent agriculture show that locational distribution of pulses and distance from the village settlement are inversely related on weak statistical grounds as against the hypothesised distribution. However, in case of Balola the formulated proposition holds good, since under, strictly rainfed agriculture the locational distribution of pulses shows a trend which lies in conformity with that of the laid down hypothesis. The villages which are having good canal/tube-well irrigation facilities invariably show a distribution of pulses which is in conformity with the hypothesised distribution, which is statistically strong only in Silokhra village. It is therefore, generalised that within arid and semi-arid climatic conditions, the provision of irrigation facilities and the extensification of pulses are positively interrelated.

Keeping the above discussion in mind, the model of agricultural location which seems to be applied in semi-arid conditions of the district of Gurgaon explains the following.

Intensity of cropping

At macro-level the intensity of cropping increases with increasing irrigation intensity. However, from urban centre if irrigation facilities are available it increases with distance. It decreases with distance away from canal. The Patakpur Mionr Canal is not a perennial canal and for most parts in Rabi seasons it remains dry. The irrigation is carried on by tube-wells which are private in general. Canal for irrigation purpose is therefore, ineffective in the Rabi seasons. Among the lines of communication, the gradient of cropping intensity is steeper for railways than roads. At micro-level (village level), the intensity of cropping generally decreases outwards from the village habitat, irrespective of whether the village has a rainfed, or an irrigation propelled agriculture, or the village is situated in immediate neighbourhood of an urban centre (big/small), a road or a canal.

Cereals

At macro-level, Kharif cereals, wich are less water demanding crops, and generally depend on rainfall the rising trend of their distribution is due to real extensification in respect of increasing distance from urban centres and the lines of communication. The distribution of Rabi cereals among which wheat dominates, its distribution is affected primarily by irrigation availability, and secondly, by the factor of demand which is generated by the volume of population of the neighbouring cities. At micro-level, in rainfed villages, the locational distribution of both Kharif and Rabi cereals decreases with distance from the village settlement while reverse is true for those villages which are having good irrigation facilities.

Vegetables

At macro-level vegetables, which require frequent visits of the farmers for the sake of protection from stray animals, and are perishable products, Therefore, vegetables require a ready market, and their locational distribution in both Kharif and Rabi seasons follows Von Thunen's proposition partially and declines with increasing distance not only from the market places. Moreover, with respect to the lines of communication, canal, and decreasing tube-well irrigation facilities. At micro-level as well, the same is true.

Oil Seeds

At macro-level the locational distribution of oil seed crops distribution in both Kharif and Rabi cropping seasons, in general show a mild increasing tendency with distance from the urban centres as well as with increasing tube-well irrigation facilities. The lines of communication and distance from the canal has no bearing on the extensification of these crops. At micro-level in study area, in rainfed agricultural system with distance from the village settlement, acreage under Rabi oil seeds decreases. In villages with good irrigation facilities, Kharif oil seeds do not seem depending much upon irrigation which is evident from their fluctuating trend of distribution. The Rabi oil seeds, however, show a positive tendency of distribution, that is, area under oil seed crops increases with distance. It is in fact not out of extensive agriculture, but due to putting large area under oil seeds and is rather a case of commercial farming of these crops.

Fodder

Locational distribution and concentration of fodder crops indirectly indicates about the developmental state of dairy farming. Fodder at macro-level in general, it is established that locational distributional of fodder crops both in Kharif and Rabi seasons decreases with distance from urban centers and the lines of communication. However, with respect to distance from canal and tube-well irrigation the trend is seen opposite to that postulated i.e. with increasing distance from the canal a tendency of decrease (Rabi season) and with increasing intensity of tube-well irrigation a general miled increase establishes that fodder cultivation and its locationl distribution in the study area with semi-arid climate, is to some extent dependent upon water supply. At micro-level in both Kharif and Rabi cropping seasons, in both rainfed as well as irrigated environment, with respect to increasing distance from the village habitat, the declining tendency of fodder distribution is established.

Pulses

At macro-level, it is establishd that gnerally a declining locational trend of pulses is established with respect to distances from urban centres. The factor of eccessibility i.e. nearness to a line of communication, apparently has no bearing on the location of pulses. However, provision of better irrigation facilities seems to have a positive bearing on the locational distribution of pulses. In rest of the cases, the locational distribution of pulses is found opposite to the respective propositions. The apparent low level extensification of pulses around Gurgaon (Rabi season) and in angular zones about Sohna, is towards intensive commercial farming of pulses under the pressure of demand generated by Delhi Gurgaon and Sohna cities. At micro-level in a system of rainfed agriculture, the distribution of pulses generally show a decreasing trend, while in an atmosphere of good irrigation (tube-well or canal) an extension in the farming of pulses is found.

Keeping the above facts on record, it is put forward that, the model of Von Thunen in the present day world along with its many complexities, for the district of Gurgaon is not acceptable in toto. However, it is applicable only to cropping inensity, and vegetables distribution. The location of fodder crops, which sets a defenet decreasing trend away from the urban settlements and the lines of communication, resembles the case of low value and high bulk product which according to Von Thunen fined a location more comfortable, if ease of transportation is there. In other cases the hypotheses do not hold good.

In fact, the impact of other factors on the location of crops, should also not be underestimated. These factors which are relief variations, soil types, technological developments and cultural patterns, as well as, subjective crop preferences of different ethnic rural communities that modify cropping patterns in the study area append more significance to them. In order to improve agriculture in the study area following suggestions are put forward.

Semi-arid conditions and limited sub-soil water makes it significant to promote scientific management of ground water through sprinkler and drip irrigation systems. This will help arresting wasteful losses of water through evaporation on one hand and would slow down the over exploitation of fresh sub-soil water on the other. Consequently, a check will be applied on the recession of water table. A micro-level i.e., village level study of aquifers and quality of ground water is necessary for the assessment of the potential of ground water resources. Efforts should be made in order to ascertain a regular flow of water in Gurgaon Canal on one hand as well as to increase its command area by extending the length of its distributaries particularly in areas where sub-soil water is saline.

Gurgaon is a major city of the area, both Gurgaon and smaller cities with their adjoining areas are influenced by Delhi in respect of the marketability of agricultural produce. Thunen's dictum stands modified in respect of cereals particularly wheat and the modified assertion is that wheat being a Rabi crop, requires several waterings and its locational pattern is not dependent on distance from the market, but from the source of irrigation. Therefore, above mentioned efforts should be made to increase the irrigated area and to promote water management practices. This will lead to increase production and with the government procurement policy, which are yet to be made further effective, the farmers can sell their produce to the procurement centres and keep the remaining cereals for their family's needs.

In respect of vegetables Thunen's dictum holds good, however, there is a need to further improve the transport system both in respect of the towns of the district and towords Delhi.

APPENDIX - I
MACRO-LEVEL ZONING SCHEMES AND SAMPLE VILLAGES

CIRCULAR ZONING AROUND GURGAON

Zones	No. of Villages Actual	(20% Sample)	Village Names (Block Name)/Location code
I	2	1	Silokhra (Gurgaon)/61
II	5	1	Allahwardi (Gurgaon)/50
III	17	3	Chakarpur (Gurgaon)/55, Islampur (Gurgaon)/76, Basai (Gurgaon)/65
IV	16	3	Nathupur (Gurgaon)/53, Garoli Kalan (Gurgaon)/80, Ghasaula (Gurgaon)/116
V	9	2	Dhankot (Gurgaon)/40, Medawas (Sohna)/128
VI	14	3	Bahrempur (Sohna)/125, Harsaru (Gurgaon)/82, Hassanpur (Sohna)/134
Total	**63**	**13**	

CIRCULAR ZONING AROUND NUH

I	3	1	Palri (Nuh)/127
II	13	3	Jakohpur (Nuh)/130, Sonkh (Nuh)/125, Baroji (Nuh)/161
III	9	2	Khori Nuh (Nuh)/162, Tapkan (Nuh)/85
IV	13	3	Nizampur Nuh (Nuh)/170, Meoli (Nuh)/164, Rehna (Nuh)/86
V	26	5	Mohammadpur Nuh (Nuh)/165, Nanuka (Taoru)/81, Kurali Sohna (Nuh)/119, Badka Alimuddin (Nuh)/89, Ghasera (Nuh)/148
VI	31	6	Mahwan (Nuh)/90, Bhogipur (Taoru)/59, Kotla (Nuh)/166, Birsika (Nuh)/184, Mailawas (Nuh)/139, Naharpur (Taoru)/58
Total	**95**	**20**	

Contd.....

OBLONGED ZONING ALONG DELHI-JAIPUR RAILWAY

I	9	2	Dhanwanpur (Gurgaon)/64, Tajnagar (Farrukhnagar)/91
II	10	2	Dhankot (Gurgaon)/40, Khandevila (Farrukhnagar)/21
III	8	2	Daultabad Part (Gurgaon)/43, Mahchana (Farrukhnagar)/20
IV	5	1	Karola (Farrukhnagar)/18
V	6	1	Iqbalpur (Farrukhnagar)/02
VI	5	1	Shekhupur Majri (Farrukhnagar)/14
Total	**43**	**9**	

PARALLEL ZONING ALONG DELHI-ALWAR HIGHWAY (NUH-NAGINA PART)

I	16	3	Bhadas (Nagina)/45, Dundaheri (Nuh)/155, Ranika (Nagina)/111
II	17	3	Sultanpur Nuh (Nagina)/19, Jogipur (Nuh)/156, Adbar (Nuh)/171
III	14	3	Hussainpur (Nuh)/172, Jargali (Nagina)/113, Umra (Nagina)/22
IV	16	3	Manaki (Nuh)/152, Khan Mohammadpur (Nagina)/23, Dhadala (Nagina)/65
V	12	2	Maujpur (Nuh)/189, Bazidpur (Nagina)/32
VI	12	2	Alduka (Nuh)/178, Ter (Punhana)/70
Total	**87**	**16**	

PARALLEL ZONING ALONG PATAKPUR MINOR DISTRIBUTARY (GURGAON CANAL)

I	16	3	Rajpur (Punhana)/76, Bikti (Punhana)/153, Naharpur (Punhana)/130
II	10	2	Runera (Punhana)/89, Shamsabad Khurd (Punhana)/150
III	6	1	Bisru (Punhana)/81
IV	5	1	Laphuri (Punhana)/84
V	1	1	Jharokri (Punhana)/143
VI	4	1	Bichhor (Punhana)/147
Total	**42**	**9**	

Contd.....

CLOCK-WISE ANGULAR ZONING ABOUT SOHNA

I	19	4	Rethora (Nuh)/135, Basai (Nuh)/91, Rupaheri (Nuh)/117, Raipur (Sohna)/186
II	15	3	Mahwan (Nuh)/90, Sehsaula (Taoru)/41, Bidhuwas (Taoru)/44
III	12	2	Sanp-ki-Nagli (Sohna)/183, Goela (Taoru)/49
IV	9	2	Mohammadpur Gujar (Sohna)/184, Sarai (Taoru)/08
V	2	1	Gairatpur Bas (Sohna)/167
VI	5	1	Ghamroj (Sohna)/169
Total	**62**	**13**	

CLOCK-WISE ANGULAR ZONING ABOUT NAGINA

I	6	1	Rajaka (Nagina)/17
II	10	2	Hasanpur Nuh (Nagina)/20, Bhadas (Nagina)/43
III	18	4	Sukhpuri (Nagina)/34, Banarsi (Nagina)/37, Imamnagar (Nagina)/60, Balai (Nagina)/62
IV	8	2	Marora (Nagina)/63, Jhimrawat (Nagina)/67
V	11	2	Nai Nagla (Nagina)/108, Kherli Kalan (Nagina)/105
VI	6	1	Sakras (Ferozpur Jhirka)/112
Total	**59**	**12**	
G. Total	**451**	**92**	

APPENDIX-II

CATEGORISATION OF CROPS INTO CROP-GROUPS

Crop Group(s)	Crops Included
1. Kharif Cereals	Rice (Oryza sativa), Jowar/ Sorghum (Sorghum vulgare), Bajra/ Bulrush Millet (Pennisetum typhoides), Maize (Zea mays).
2. Kharif Vegetables	Potato (Solanum tuberosum), Sweet Potato (Ipomoea batatas), Onion (Allium cepa), Garlic (Allium sativum), Red Chille (L. capsa), Coriander Leaves (Coriandum sativum), Pumpkin (Cucurbita pepo), Tomato (Lycopersicum esculentum), Cauliflower (L. cauliflora), Beans (Vicea feba, Phaseolus vulgaris), Brinjal (S. vatingana), Raddish (Rephanus sativus), and others.
3. Kharif Oil Seeds	Til (S.tila), Sunflower (Helianthus).
4. Kharif Pulses	Urd/Black Gram (Vigna mungo), Moong/Green Gram (Vigna radiata), Masur/Lentil (Lens culinaris), Moth/Brown Gram (Vigna aconitifolia).
5. Kharif Fodder	Gowar/Cluster Beans (Cyamopsis tetragonoloba), Pearl Millet/Bulrush Millet (P. typhoideum), Sorghum (Sorghum vulgare).
6. Rabi Cereals	Wheat (Triticum aestivum), Barley (Hordeum vulgare), Gram (Cicer arietinum).

Contd.....

7.	Rabi Vegetables	Cabbage (Brassica oleracae), Carrot (L. carota), Tomato (L.esculantum), Turnip (B. rutabega), Raddish (R.sativus), Cucumber (Cucumis sativus), Others.
8.	Rabi Oil Seeds	Taramira, Rape Seed (Brassica napsus), Mustard (Brassica campestris).
9.	Rabi Pulses	Peas (Pisum sativum), Arhar/Tur/ Red Gram (Cajanus cajan).
10.	Rabi Fodder Crops	Barseem/Egyptian Clover (Trifolium alexandria), Methi/ Fenugreak (Trigonella foenum), Lusan/Alfa Alfa (Medicago sativa), Senji/Indian clover (Melilotus indica).

APPENDIX - III

CIRCULAR ZONING AROUND GURGAON CITY

1993-94

Zones	Width (Kms.)	Net Sown Area (Hectares)	Cropping Intensity (%)	Irrigated Area (Hectares)			
				Canal	T.Wells	Others	Total (% to net sown Area)
I	0-2	125	7.2	0	63	0	50.40
II	2-4	104	16.35	0	85	0	81.73
III	4-6	818	18.95	0	458	0	64.66
IV	6-8	409	21.27	0	295	0	53.30
V	8-10	1359	2.43	0	623	0	45.84
VI	10-12	1061	36.95	0	831	0	78.32

AREA UNDER KHARIF CROPS (%)

Zones	Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Total
I	7.20	0.00	1.60	16.00	2.40	27.20
II	16.35	13.46	1.92	5.77	1.92	39.42
III	23.59	1.59	0.98	11.15	0.98	38.39
IV	21.03	1.96	3.42	6.36	1.96	34.72
V	13.83	1.84	0.74	5.00	0.00	22.37
VI	29.22	1.51	6.22	3.15	0.19	41.85

AREA UNDER RABI CROPS (%)

Zones	Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Total
I	37.60	8.80	20.00	8.00	5.60	80.00
II	49.04	2.88	8.65	14.42	1.92	76.92
III	36.67	3.79	33.62	4.04	2.44	80.56
IV	44.25	4.16	33.01	4.65	0.49	86.31
V	47.76	1.10	29.14	1.10	0.96	80.06
VI	59.66	1.13	22.41	1.41	1.04	85.67

APPENDIX - IV

CIRCULAR ZONING AROUND NUH CITY

1993-94

Zones	Width (Kms.)	Net Sown Area (Hectares)	Cropping Intensity (%)	Irrigated Area (Hectares)			
				Canal	T.Wells	Others	Total (% to net sown Area)
I	0-2	140	54.29	52	0	0	37.14
II	2-4	453	36.42	48	71	0	26.27
III	4-6	377	33.16	93	30	0	32.63
IV	6-8	1662	24.97	33	140	0	10.41
V	8-10	1413	27.81	274	98	0	26.33
VI	10-12	1205	44.56	60	529	0	48.87

AREA UNDER KHARIF CROPS (%)

Zones	Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Total
I	22.14	3.57	0.71	25.71	2.14	54.29
II	15.45	2.86	0.22	19.87	0.00	38.41
III	30.50	2.12	0.53	1.59	0.00	34.75
IV	35.62	0.06	0.00	2.41	0.00	38.93
V	22.22	0.99	0.35	3.96	0.21	27.88
VI	39.34	0.50	1.90	6.97	0.08	48.96

AREA UNDER RABI CROPS (%)

Zones	Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Total
I	37.86	9.29	22.00	27.14	3.57	100.00
II	50.11	5.74	29.80	7.73	4.64	98.08
III	46.68	10.08	41.38	0.00	0.00	98.41
IV	46.21	4.21	30.69	1.81	0.90	86.04
V	64.12	0.99	32.20	1.70	0.57	99.93
VI	49.88	2.41	36.93	4.56	1.66	95.60

APPENDIX - V

OBLONGED ZONING ALONG DELHI-JAIPUR RAILWAY

1993-94

Zones	Width (Kms.)	Net Sown Area (Hectares)	Cropping Intensity (%)	**Irrigated Area (Hectares)**			
				Canal	T.Wells	Others	Total (% to net sown Area)
I	0-2	649	51.46	0	608	0	93.68
II	2-4	1460	27.26	0	881	0	60.34
III	4-6	1299	7.24	0	1113	0	86.99
IV	6-8	714	7.84	0	665	0	93.14
V	8-10	163	41.72	0	156	0	95.71
VI	10-12	230	16.09	0	208	--	90.43

AREA UNDER KHARIF CROPS (%)

Zones	Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Total
I	45.61	1.69	1.85	7.09	0.31	56.55
II	30.48	1.03	1.51	6.10	0.41	39.72
III	9.39	0.54	0.08	2.69	0.00	12.70
IV	5.88	0.14	0.28	2.80	0.00	9.10
V	18.40	3.07	0.00	16.56	0.00	39.26
VI	13.04	0.00	1.30	2.17	0.00	16.52

AREA UNDER RABI CROPS (%)

Zones	Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Total
I	63.02	0.31	29.28	2.31	0.00	94.92
II	57.40	0.96	27.47	1.03	0.00	87.53
III	82.14	0.77	10.47	1.15	0.00	40.53
IV	96.92	0.14	1.54	0.14	0.00	98.74
V	57.66	0.61	41.71	0.00	0.00	100.00
VI	94.35	0.00	5.22	0.00	0.00	99.57

APPENDIX - VI

PARALLEL ZONING ALONG DELHI-ALWAR HIGHWAY

1993-94

Zones	Width (Kms.)	Net Sown Area (Hectares)	Cropping Intensity (%)	Irrigated Area (Hectares)			
				Canal	T.Wells	Others	Total (% to net sown Area)
I	0-2	878	49.54	9	45	12	7.52
II	2-4	1011	26.51	--	36	--	3.56
III	4-6	1035	16.23	148	78	--	21.84
IV	6-8	282	49.29	69	12	--	28.72
V	8-10	249	74.70	--	63	--	25.30
VI	10-12	1131	72.94	312	91	--	35.63

AREA UNDER KHARIF CROPS (%)

Zones	Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Total
I	32.00	0.68	0.75	16.15	0.23	50.00
II	23.84	0.40	0.40	3.76	0.20	28.29
III	16.23	0.10	0.20	0.80	0.10	17.39
IV	39.07	1.77	3.55	4.61	0.35	49.29
V	69.01	2.41	0.00	3.61	0.80	76.70
VI	67.02	0.88	1.76	5.66	0.62	77.45

AREA UNDER RABI CROPS (%)

Zones	Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Total
I	40.88	2.51	68.00	5.69	1.37	99.54
II	47.28	1.29	45.10	3.26	1.18	97.92
III	24.54	0.90	71.21	1.40	1.00	89.29
IV	50.35	0.00	47.16	0.00	0.35	96.10
V	93.57	0.00	3.16	0.80	0.00	97.99
VI	53.23	0.26	37.93	1.24	1.33	95.49

APPENDIX - VII

PARALLEL ZONING ALONG PATAKPUR MINOR CANAL

1993-94

Zones	Width (Kms.)	Net Sown Area (Hectares)	Cropping Intensity (%)	Irrigated Area (Hectares)			
				Canal	T.Wells	Others	Total (% to net sown Area)
I	0-2	383	57.44	0	177	0	46.21
II	2-4	242	55.78	0	139	0	57.43
III	4-6	991	64.08	365	200	0	57.01
IV	6-8	195	70.76	0	145	0	74.36
V	8-10	236	33.89	0	68	0	28.81
VI	10-12	1495	52.11	623	607	0	82.27

AREA UNDER KHARIF CROPS (%)

Zones	Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Total
I	32.38	10.44	7.05	7.30	1.57	59.79
II	31.40	9.92	8.68	6.20	1.65	57.85
III	51.78	2.62	0.10	17.66	0.20	72.35
IV	64.10	0.51	1.50	3.07	1.02	70.26
V	24.58	0.42	0.00	10.16	0.00	35.59
VI	30.97	0.07	0.07	15.38	0.07	52.11

AREA UNDER RABI CROPS (%)

Zones	Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Total
I	79.90	2.35	14.36	0.78	0.26	97.65
II	67.36	1.24	29.34	0.00	0.00	97.93
III	83.25	0.10	7.87	0.10	0.40	91.73
IV	97.44	1.02	1.02	0.51	0.00	100.00
V	93.64	0.42	4.42	0.00	0.42	98.31
VI	80.00	0.07	19.40	0.13	0.40	100.00

APPENDIX - VIII

ANGULAR ZONING ABOUT SOHNA

1993-94

Zones	Width (Kms.)	Net Sown Area (Hectares)	Cropping Intensity (%)	Irrigated Area (Hectares)			
				Canal	T.Wells	Others	Total (% to net sown Area)
I	0-2	763	31.59	71	115	0	24.38
II	2-4	1080	30.93	0	385	0	35.64
III	4-6	403	57.57	0	277	0	68.73
IV	6-8	296	59.46	0	224	0	75.67
V	8-10	542	63.47	0	384	0	70.84
VI	10-12	466	31.12	0	195	0	41.85

AREA UNDER KHARIF CROPS (%)

Zones	Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Total
I	26.21	0.66	1.97	9.83	0.92	37.35
II	24.07	0.37	0.37	7.87	0.56	33.70
III	54.34	1.98	0.00	8.93	0.50	66.25
IV	47.97	1.35	0.34	15.88	2.03	68.58
V	60.14	1.48	2.77	4.43	1.85	70.66
VI	39.48	0.43	0.21	0.21	0.43	42.27

AREA UNDER RABI CROPS (%)

Zones	Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Total
I	67.10	1.31	24.12	0.66	0.52	94.23
II	46.02	1.85	45.00	2.13	2.78	97.20
III	65.51	2.23	17.87	1.74	2.98	91.31
IV	54.39	5.40	24.32	3.38	3.38	90.88
V	64.58	2.95	23.62	0.92	0.74	92.80
VI	82.83	1.72	3.00	0.43	0.86	88.84

APPENDIX - IX

ANGULAR ZONING ABOUT NAGINA

1993-94

Zones	Width (Kms.)	Net Sown Area (Hectares)	Cropping Intensity (%)	Irrigated Area (Hectares)			
				Canal	T.Wells	Others	Total (% to net sown Area)
I	0-2	240	29.58	0	0	0	0.00
II	2-4	990	20.91	112	69	0	18.38
III	4-6	944	15.04	0	35	0	3.71
IV	6-8	1541	31.15	0	416	0	27.00
V	8-10	439	33.48	0	146	0	33.38
VI	10-12	1753	49.34	0	1141	0	65.09

AREA UNDER KHARIF CROPS (%)

Zones	Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Total
I	31.67	0.41	0.00	0.41	0.00	32.50
II	22.42	0.24	0.24	0.51	0.54	23.41
III	11.86	0.21	0.00	4.87	0.00	16.95
IV	22.78	0.78	1.17	10.77	0.00	32.12
V	23.46	0.46	0.91	8.88	0.00	33.71
VI	32.69	4.34	2.80	11.58	0.00	51.40

AREA UNDER RABI CROPS (%)

Zones	Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Total
I	32.92	6.25	49.58	6.25	2.08	97.08
II	18.69	0.40	78.79	0.00	0.10	97.98
III	49.74	0.64	56.53	1.17	0.85	98.09
IV	30.76	1.04	62.69	0.71	0.58	99.03
V	33.94	1.82	63.55	0.23	0.23	99.77
VI	44.50	2.17	49.00	1.60	0.68	97.95

APPENDIX - X

ZONING SCHEMES AND THE RESULTS OF STATISTICAL ANALYSES (MACRO-LEVEL)

Zoning around/ along/about	Cropping Intensity	KHARIF					RABI				
		Cereals	Vegetable	O. seeds	Fodder	Pulses	Cereals	Vegetable	O. seeds	Fodder	Pulses
Gurgaon											
Coefficients of :											
Correlation	0.484	0.688	-0.289	0.571	-0.079	-0.843	0.719	-0.816	0.410	-0.774	-0.791
Regression	1.562	1.428	-0.385	0.314	-1.019	-0.226	1.629	-0.619	1.043	-1.033	-0.395
Determination	0.234	0.473	0.084	0.326	0.638	0.711	0.517	0.666	0.168	0.599	0.626
t-statistic	1.106	1.898	-0.608	1.389	2.653*	3.138*	2.069*	2.824*	0.899	2.444*	2.590*
Nuh											
Coefficients of :											
Correlation	-0.403	0.652	-0.886	0.461	-0.738	-0.605	0.634	-0.797	0.575	-0.680	-0.610
Regression	-1.181	1.592	-0.329	0.083	-2.009	-0.138	1.452	-0.779	1.017	-1.845	-0.298
Determination	0.162	0.425	0.785	0.213	0.545	0.366	0.402	0.635	0.331	0.463	0.372
t-statistic	0.882	1.721	3.816**	1.039	2.189*	1.520	1.638	2.635*	1.399	1.853	1.538
Railway											
Coefficients of :											
Correlation	-0.388	-0.721	-0.126	-0.468	0.068	--	0.505	-0.524	-0.219	-0.916	--
Regression	-1.898	-2.894	-0.039	-0.101	0.098	--	2.460	-0.050	-1.236	-0.224	--
Determination	0.151	0.518	0.016	0.219	0.005	--	0.255	0.275	0.085	0.084	--
t-statistic	0.843	2.100	0.255	1.058	0.136	--	1.171	1.233	0.609	4.582**	--

Contd.....

Zoning around/ along/about	Cropping Intensity	KHARIF					RABI				
		Cereals	Vegetable	O. seeds	Fodder	Pulses	Cereals	Vegetable	O. seeds	Fodder	Pulses
Highway											
Coefficients of :											
Correlation	0.664	0.804	0.529	0.318	-0.496	0.788	0.528	-0.879	-0.653	-0.799	-0.415
Regression	4.209	4.767	0.124	0.116	-0.727	0.057	3.234	-0.229	-4.289	-0.443	-0.063
Determination	0.441	0.646	0.280	0.101	0.246	0.620	0.278	0.772	0.426	0.638	0.172
t-statistic	1.777	2.708*	1.248	0.672	1.144	2.561*	1.242	3.692**	1.724	2.656*	0.911
Canal											
Coefficients of :											
Correlation	-0.365	-0.053	-0.904	-0.812	0.359	-0.819	0.463	-0.795	-0.289	-0.475	0.418
Regression	-1.223	-0.217	-1.178	-0.851	0.538	-0.166	1.336	-0.185	-0.814	-0.041	0.022
Determination	0.133	0.002	0.817	0.659	0.129	0.671	0.214	0.632	0.083	0.226	0.175
t-statistic	0.783	0.106	4.228**	2.781*	0.770	2.849*	1.045	2.623*	0.603	1.079	0.922
Sohna											
Coefficients of :											
Correlation	0.961	0.906	0.837	-0.058	0.292	0.611	-0.127	0.770	-0.158	0.511	0.468
Regression	0.705	0.621	0.025	-0.003	0.072	0.020	-0.073	0.053	-0.099	0.026	0.028
Determination	0.924	0.820	0.701	0.003	0.085	0.373	0.016	0.593	0.025	0.261	0.219
t-statistic	6.183**	4.274**	3.060*	0.117	0.617	1.527	0.256	2.407*	0.321	1.190	1.056
Nagina											
Coefficients of :											
Correlation	0.888	0.468	0.868	0.969	0.775	--	0.349	-0.247	-0.149	-0.398	-0.460
Regression	0.603	0.149	0.059	0.044	0.163	--	0.135	-0.023	-0.070	-0.039	-0.014
Determination	0.789	0.219	0.753	0.939	0.601	--	0.122	0.061	0.022	0.158	0.212
t-statistic	3.331*	1.060	3.497*	7.821**	2.450*	--	0.745	0.508	0.302	0.869	1.038

** Significant at 0.01 Level of Significance (Critical Value of t = 3.747)
* Significant at 0.05 Level of Significance (Critical Value of t = 2.132)

APPENDIX - XI
ZONING AT MICRO-LEVEL
CROP GROUPS/CROPPING INTENSITY
1993-94

VILLAGE GUMAT BIHARI

Zones	Width (m)	Cropping Intensity (%)	KHARIF					RABI				
			Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Cereals	Vegetables	Oil Seeds	Fodder	Pulses
I	0-250	4.1	41.5	3.8	0.0	28.3	0.0	47.2	5.7	43.4	0.0	3.8
II	250-500	5.2	41.1	1.1	0.0	24.4	0.0	64.4	2.2	28.9	2.2	2.2
III	500-750	3.1	29.3	1.7	0.0	8.6	0.0	51.7	3.4	20.7	1.7	5.2
IV	750-1000	1.7	27.9	0.0	0.0	4.4	0.0	57.4	1.5	29.4	0.0	0.0
V	1000-1250	0.4	23.3	7.7	0.0	3.3	0.0	66.7	0.0	25.0	1.7	3.3
VI	1250-1500	0.4	30.8	0.0	0.0	0.0	0.0	44.9	0.0	25.6	0.0	1.3

VILLAGE SEWKA

Zones	Width (m)	Cropping Intensity (%)	KHARIF					RABI				
			Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Cereals	Vegetables	Oil Seeds	Fodder	Pulses
I	0-250	4.1	1.77	30.8	15.4	46.2	0.0	15.4	53.8	15.4	15.4	0.0
II	250-500	8.2	36.4	10.9	25.5	27.3	0.0	45.5	5.5	47.3	1.8	0.0
III	500-750	10.3	21.4	8.6	54.3	14.3	0.0	40.0	7.1	47.1	1.4	2.8
IV	750-1000	8.0	21.7	1.1	67.4	6.5	0.0	37.0	4.3	55.4	0.0	1.1
V	1000-1250	6.4	40.0	2.7	42.7	12.0	0.0	52.0	4.0	38.7	1.3	0.0
VI	1250-1500	5.4	44.1	2.9	26.5	23.5	0.0	70.6	0.0	23.5	0.0	2.9

Contd ....

VILLAGE BALOLA

Zones	Width (m)	Cropping Intensity (%)	KHARIF					RABI				
			Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Cereals	Vegetables	Oil Seeds	Fodder	Pulses
I	0-400	1.6	31.0	5.2	0.0	27.6	1.7	34.5	3.4	58.6	3.4	0.0
II	400-800	1.5	48.2	0.8	0.0	5.5	1.2	23.7	0.4	71.1	1.2	0.0
III	800-1200	0.8	43.6	0.0	0.0	2.0	1.0	16.2	0.0	66.9	0.3	0.7
IV	1200-1600	0.3	50.6	0.0	0.0	1.7	0.9	25.8	0.0	38.6	0.0	0.4
V	1600-2000	0.0	15.7	0.0	0.0	0.0	0.5	10.5	0.0	0.0	0.0	0.5
VI	2000-2400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

VILLAGE IQBALPUR

Zones	Width (m)	Cropping Intensity (%)	KHARIF					RABI				
			Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Cereals	Vegetables	Oil Seeds	Fodder	Pulses
I	0-260	7.6	34.9	9.3	0.0	37.2	0.0	69.8	2.3	23.3	0.0	4.7
II	260-520	9.6	14.0	1.8	0.0	7.2	0.0	50.0	0.9	39.5	0.0	0.0
III	520-780	7.1	17.5	0.8	0.0	4.8	0.0	51.6	0.8	38.1	0.8	0.0
IV	780-1040	6.3	20.2	4.0	0.0	18.2	0.0	61.6	0.0	30.3	1.0	1.0
V	1040-1300	5.1	10.6	2.1	0.0	12.8	0.0	38.3	2.1	38.3	0.0	0.0
VI	1300-1560	4.0	11.4	0.0	0.0	27.3	0.0	31.8	0.0	4.6	2.3	2.3

Contd ....

VILLAGE KARAMCHANDPUR

Zones	Width (m)	Cropping Intensity (%)	KHARIF					RABI				
			Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Cereals	Vegetables	Oil Seeds	Fodder	Pulses
I	0-300	5.8	61.5	7.7	0.0	7.7	0.0	7.7	38.5	0.0	30.8	0.0
II	300-600	11.6	80.0	0.0	2.9	2.9	0.0	71.4	11.4	2.9	8.6	5.7
III	600-900	8.7	85.4	2.1	0.0	0.0	2.1	72.9	4.2	4.2	2.1	2.1
IV	900-1200	4.6	69.6	2.2	2.2	2.2	2.2	82.6	2.2	2.2	2.2	4.3
V	1200-1500	1.2	63.0	0.0	0.0	0.0	0.0	67.4	0.0	10.9	2.2	6.5
VI	1500-1800	0.0	56.3	0.0	0.0	0.0	6.3	75.0	0.0	18.8	0.0	0.0

VILLAGE SILOKHRA

Zones	Width (m)	Cropping Intensity (%)	KHARIF					RABI				
			Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Cereals	Vegetables	Oil Seeds	Fodder	Pulses
I	0-350	0.3	3.6	5.8	0.0	17.5	0.0	48.2	8.8	2.2	6.6	0.0
II	350-700	0.2	9.0	4.8	0.6	9.6	0.0	54.5	4.2	12.0	4.8	0.0
III	700-1050	0.2	13.2	5.4	1.2	8.4	1.8	61.7	3.6	9.0	4.8	1.8
IV	1050-1400	0.0	8.1	1.6	0.5	4.3	1.6	58.1	2.2	6.5	3.8	1.1
V	1400-1750	0.0	1.1	8.3	0.0	15.0	1.7	75.0	5.0	8.3	0.0	3.3
VI	1750-2100	0.0	0.3	0.0	0.0	6.3	0.0	31.3	6.3	12.6	0.0	6.3

APPENDIX - XII

ZONING SCHEMES AND THE RESULTS OF STATISTICAL ANALYSES (MICRO-LEVEL)

Village(s)	Cropping Intensity	KHARIF					RABI				
		Cereals	Vegetable	O. seeds	Fodder	Pulses	Cereals	Vegetable	O. seeds	Fodder	Pulses
Gumat Bihari											
Coefficients of :											
Correlation	-0.924	-0.782	-0.716	--	-0.940	--	0.007	-0.906	-0.631	-0.165	-0.414
Regression	-0.004	-0.012	-0.002	--	-0.024	--	0.0001	-0.004	-0.011	-0.0004	-0.016
Determination	0.855	0.612	0.513	--	0.883	--	0.004	0.821	0.398	0.027	0.171
t-statistic	4.847**	2.513*	2.053*	--	5.486**	--	0.013	4.277**	1.626	0.334	0.993
Sewka											
Coefficients of :											
Correlation	-0.029	0.755	-0.826	0.325	-0.627	--	0.859	-0.724	0.080	-0.715	0.490
Regression	-0.0001	0.026	-0.019	0.014	-0.019	--	0.333	-0.031	0.0003	-0.009	0.001
Determination	0.001	0.569	0.682	0.106	0.394	--	0.739	0.524	0.006	0.512	0.240
t-statistic	0.058	2.302*	2.929*	0.688	1.611	--	3.362*	2.100*	0.159	2.049*	1.123
Balola											
Coefficients of :											
Correlation	-0.964	-0.651	-0.729	--	-0.773	-0.978	-0.885	-0.713	-0.883	-0.829	0.208
Regression	-0.001	-0.017	-0.002	--	-0.011	-0.001	-0.014	-0.001	-0.038	-0.001	0.0001
Determination	0.929	0.423	0.531	--	0.597	0.957	0.783	0.508	0.779	0.686	0.043
t-statistic	7.210**	1.714	2.132*	--	2.435*	9.481**	3.802**	2.032**	3.765**	2.960*	0.426

Contd.....

Village(s)	Cropping Intensity	KHARIF					RABI				
		Cereals	Vegetable	O. seeds	Fodder	Pulses	Cereals	Vegetable	O. seeds	Fodder	Pulses
Iqbalpur											
Coefficients of :											
Correlation	-0.878	-0.742	-0.673	--	-0.083	--	-0.815	-0.468	-0.416	0.688	-0.312
Regression	-0.003	-0.013	-0.004	--	-0.0002	--	-0.023	-0.001	-0.011	0.001	-0.001
Determination	0.770	0.551	0.452	--	0.006	--	0.663	0.218	0.172	0.473	0.097
t-statistic	3.662*	2.216*	1.817	--	0.166	--	2.810*	1.057	0.914	1.897	0.658
Karamchandpur											
Coefficients of :											
Correlation	-0.781	-0.437	-0.688	-0.260	-0.800	0.687	0.650	-0.822	0.878	-0.790	0.087
Regression	-0.006	-0.008	-0.003	-0.006	-0.004	0.003	0.031	-0.021	0.011	-0.016	0.0004
Determination	0.609	0.191	0.472	0.067	0.639	0.472	0.422	0.675	0.770	0.624	0.007
t-statistic	2.499*	0.972	1.894	0.538	2.663*	1.891	1.711	2.884*	3.659*	2.578*	0.174
Silokhra											
Coefficients of :											
Correlation	-0.925	0.859	-0.392	-0.276	-0.460	0.281	-0.098	-0.267	0.537	-0.946	0.904
Regression	-0.0002	0.012	-0.001	-0.000	-0.003	0.0004	-0.002	-0.0009	0.003	-0.004	0.003
Determination	0.855	0.737	0.153	0.076	0.211	0.078	0.009	0.071	0.288	0.894	0.816
t-statistic	4.867**	3.351*	0.851	0.575	1.037	0.584	0.196	0.553	1.273	5.822**	4.217**

** Significant at 0.01 Level of Significance (Critical Value of $t = 3.747$)
* Significant at 0.05 Level of Significance (Critical Value of $t = 2.132$)

APPENDIX-XIII

TESTED HYPOTHESES

MACRO - LEVEL

Zoning Schemes	Cropping Intensity	Kharif Crop Groups: Cereals	Vegetables	Oil Seeds	Fodder	Pulses	Rabi Crop Groups: Cereals	Vegetables	Oil Seeds	Fodder	Pulses
Around Gurgaon	X••	X•	X•	X•	✓	X	✓	✓	X•	✓	X
Around Nuh	X•	X•	✓	X•	✓	X••	X•	✓	X•	X•	X••
Along Railway	X•	X••	X•	X••	X••	☐	X•	X•	X••	✓	☐
Along Highway	X••	✓	X••	X•	X•	✓	X•	✓	X••	✓	X••
Along Canal	X•	X••	✓	X	X••	X••	X•	✓	X••	X••	X•
About Sohna	✓	X	✓	X•	X••	X••	X••	✓	X•	X••	X••
About Nagina	✓	X••	✓	X	X	☐	X•	X••	X•	X•	X•
MICRO-LEVEL											
Village Gumat Bihari	✓	X	✓	☐	X	☐	X•	✓	X••	X••	X••
Village Sewka	X•	✓	✓	X•	X••	☐	✓	✓	X•	X	X•
Village Balola	✓	X••	✓	☐	X	X	X	✓	X	X	X•
Village Iqbalpur	✓	X	X•	☐	X••	☐	X	X•	X••	X•	X••
Village Karamchancpur	✓	X••	X•	X••	X	X•	X•	✓	✓	X	X•
Village Silokhra	✓	✓	X•	X••	X••	X•	X••	X•	X•	X	✓

✓ Hypothesis accepted with solid statistical support

X Hypothesis rejected with solid statistical support

X• Hypothesis rejected for inadequate statistical support in favour of hypothesis

X•• Hypothesis Rejected for inadequate statistical support against the hypothesis

☐ Hypothesis not tested for paucity of data

BIBLIOGRAPHY

Alexander, J.W. (1963), *Economic Geogrphy*, Englewood Cliffs, New Jersey : Prentice-Hall.

Alonso, W. (1960), A Theory of the Urban Land Market, *Papers and Proceedings*, *Regional Science Association* **6.**

Alonso, W. (1964), *Location and Land Use : Towards a General Theory of Land Rent,* Cambridge, Massachusetts : Harvard University Press.

Alonso, W. (1967), A Re-formulation of Classical Location Theory and Its Relation to Rent Theory, *Papers and Proceedings, Regional Science Association* **19.**

Beckmann, M.J. (1955), The Economics of Location, *Kyklos* **8**.

Beckmann, M.J. (1958), City Hierarchies and the Distribution of City Size, *Economic Development and Cultural Change* **6**.

Bishnoi, S.S. (1994), *Geohydrological Conditions and Scope of Ground Water Development in District Gurgaon (Haryana),* Gurgaon: Ground Water Cell, Agricultural Department.

Bläiki, P.M. (1971), Spatial Organisation of Agriculture in Some North Indian Villages, Part-I and II, *Transactions of Institute of British Geographers*, **52**.

Bowler, I.R. (1979), *Government and Agriculture: A Spatial Perspective,* London: Longman.

Bunge. W. (1966), *Theoritical Geography*, Lund Studies in Geography, Ser. C.

Cannon, T.G. (1975), Geography and Underdevelopment, *Area* 7.

Chisholm, M. (1963), Tendencies in Agricultural Specialisation and Regional Concentration of Industry, *Papers and Proceedings, Regional Science Association* **10**.

Chisholm, M. (1966), *Geography of Economics,* London : Bell, New York : Praeger.

Chisholm, M. (1967), General System Theory and Geography, *Transactions of the Institute of British Geographers* **42**.

Chisholm, M. (1971), In Search of a Basis for Location Theory : Micro Economics or Welfare Economics in C. Board, R.J. Chorley, P. Hagget, D.R. Stoddart (eds.) *Progess in Geography*, Vol. **3**, London : Edward Arnold.

Chorely, R.J. and P. Hagget (1967), *Models in Geography*, Englewood Cliffs, New Jersey : Prentice-Hall.

Christaller, W. (1966), *Central Places in Southern Germany,* (C.W. Baskin, trans.), Englewood Cliffs, New Jersey : Prentice-Hall.

Coleman, A. (1969), A Geographical Model for Land Use Analysis, *Geography,* Vol. **54**, No. 242.

Conkling, E.C. and M. Yeates (1976), *Man's Economic Environment,* New York: Mc Graw-Hill.

Cliff, A.D. (1973), A Note on Statistical Hypothesis Testing, *Area* **5**.

Cromley, R.G. (1982), The Von Thunen Model and Environmental Uncertainity, *Annals of the Association of American Geographers,* Vol. **72** No. 3.

De Lisle, D. de G. (1982), Effects of Distance on Cropping Patterns Internal to the Farm, *Annals of the Association of American Geographers,* Vol. **72** No. 1.

Dunn, E.S. (1954), *The Location of Agricultural Production*, Gainesville: University of Florida Press.

Dunn, E.S. (1965), The Market Potential Concept and the Analysis of Location, *Papers and Proceedings*, *Regional Science Association* **2**.

Ellefsen, R.A. (1962), City Hinterland Relationship in India in R. Turner (ed), *India's urban Future,* Bombay: Oxford University Press.

Evans, N.J. and C. Morris (1997), Towards a Geography of Agri-environmental Policies in England and Wales, *Geoforum,* Vol. **28** No.2.

Ghaffar, A. and Guy M. Robinson (1997), Restoring the Agricultural Landscape: The impact of Government Policies in East Lothian, Scotland, *Geoforum,* Vol. **28** No. 2.

Garrison, W.L. and D.F. Marble (1957), The Spatial Structure of Agricultural Activities, *Annals of the Association of American Geographers* **47**.

Gasson, R. (1996), The Changing Location of Intensive Crops in England and Wales, *Geography* **51**.

Goodman, L.A. (1954), Kolmogorov-Smirnov Tests for Psychological Research, *Psychological Bulletin* **5**.

Gottmann, J. (1961), *Megalopolis: The Urbanized Northeastern Seaboard of the United States,* Cambridge, Mass.: M.I.T. Press.

Gould, P. (1963), Man Against his Environment : A Game Theoritic Framework, *Annals of the Association of American Geographers* **53.**

Griffin, E. (1973), Testing of Von Thunen Theory in Uruguay, *Geographical Review*, L XIX.

Grotewald, A. (1959), Von Thunen in Retrospect, *Economic Geography* **35**.

Haggett, P. (1965), *Locational Analysis in Human Geography*, London: Arnold.

Haggett, P., A. D. Cliff and A. F. (1977), *Locational Models*, London : Edward Arnold (Publisers) Limited.

Hall, P. (ed.) (1966b), *Von Thunen's Isolated State*, London : Pregamon.

Hammond, R. and P.S. Mc Cullagh (1977), *Quantitative Techniques in Geography-An Introduction*, Great Britain : Oxford University Press.

Harvey, D.W. (1966), Theoritical Concepts and the Analysis of Land Use Patterns in Geography, *Annals of the Association of American Geographers* **56**.

Haworth, J. and P. Vincent (1974), Calculation of Prediction Limits in a Linear Regression, *Area* **6**.

Hazel, B. and A. Browne (1996), Export Horticulture Production in Sub-Saharan Africa-the Incorporation of the Gambia Geography, *Journal of Geographical Association,* Vol. **81,** No. 350, Part-I.

Helvig, M. (1964), Chicago's External Truck Movements, University Chicago, *Development of Geography Research Paper* **90**.

Heyes, A. G. (1996), Optimal Taxation of Flow Pollutants When Firms May also Inflict Catastrophic Environmental Damage, *Environmental and Resource Economics* **7**.

Hoover, E.M. (1948), *The location of Economic Activity*, New York : Mc Graw-Hills.

Horton, R.E. (1945), Erosional Development of Streams and their Drainage Basins: Hydro-physical Approach to Quantitative Morphology, *Bulletin of Geological Society of America* **56**.

Hovarth, R.J. (1969), Von Thunen's Isolated State and the Area Around Addis Ababa, Ethopia, *Annals of the Association of American Geographers* **59**.

Johnston, R.J., P. J. Taylor and M. Watts (1975), *Geographies of Global Change: Re-mapping the World in Late Tweentieth Century*, U.K.: Blackwell Oxford, U.S.A.: Cambridge.

Jonasson, O. (1925,26), Agricultural Regions of Europe, *Economic Geography* **1** and **2**.

Khan, M. Firoz and Fakhruddin (1979), Spatial Analysis of Agricultural Land Use: A New Approach, *The Geographer,* Vol. **XXVI,** No. 2.

Khan, M. Firoz and Fakhruddin (1981), Locational Analysis of Agricultural Land Use: A Re-assessment of Von Thunen's Theory in India, *The Geographer*, Vol. **XXVIII**, No. 1.

Losch, A. (1954), *The Economics of Location*, New Haven, Connecticut : Yale University Press.

Lloyd, P. E. and P. Dickens (1978), *Location in Space - A Theoritical Approach to Economic Geography*, London : Harper and Row Publishers.

Lutz, M.G. (1983), *Understanding Social Statistics*, New York : Mac Millan Publishing Company.

Mohammed, N. (1976), Technological Change and Diffusion of Agricultural Innovations, *The Geographer,* **XXIII**, No. 1.

Muller, P.O. (1973), Trend Surfaces of American Agricultural Patterns : A Macro-Thunian Analysis, *Economic Geography* **49**.

Munir, A. (1991), *Agricultural Productivity and Regional Development,* Delhi: Manak Publishers Private Limited.

Norcliff, G.B. (1977), *Inferential Statistics for Geographers*, London : Hutchinson and Co.

Peet, J.R. (1969), The Spatial Expansion of Commercial Agriculture in the Nineteenth Century, *Economic Geography* **45**.

Rajkumar (1994), Spatial and Temporal Changes in Wheat Cultivation in Haryana, *The Geographical Review of India,* Vol. **56** No. 2.

Rakitnikov, A.N. (1978), Von Thunen and the Significance of his work for the Geography of Agriculture, *Soviet Geography* (Review and Translations) Vol. **XIX** No. 8.

Ricardo, D. (1817, 1911), *The Principles of Political Ecocnomic and Taxation*, London: Everyman's Edition, London: J.M. Dent and Sons.

Robinson, A.H., J.B. Lindberg and L.W. Brinkman (1961), A Correlation and Regression Analysis Applied to Rural Population Densities in the Great Plains, *Annals of the Association of American Geographers* **51.**

Shafi, M. (1974), Perspectives in Measurement of Agricultural Productivity, *The Geographer,* Vol. **XXI,** No. 1.

Shafi, M. (1982), Location of Agricultural Activity-Von Thunen's Model, *The Geographer,* Vol. **XXIX,** No. 1.

Shafi, M. (1982), Perspective on Von Thunen's Theory, *The Geographer,* Vol. **XXIX,** No. 2.

Shafi, M. (1994), Ecology and Land Use/Cropping System with Special Reference to India, *The Geographer,* Vol. **XLI,** No. 2.

Schultz, T.W. (1964), *Transforming Traditional Agriculture*, London : New Haven.

Sinclair, R. (1967), Von Thunen and Urban Sprawl, *Annals of the Association of American Geographers* **57.**

Singh, J. and B. S. Ojha (1993), *Resource Planning Atlas (South and South Western Haryana),* New Delhi: National Book Organization.

Singh, J. and S.S. Dhillon (1984), *Agricultural Geography,* New Delhi: Tata Mc Graw-Hill Publishing Company Limited.

Smith, D.M. (1966), Market Gardening on Adelaide's Urban Fringe, *Economic Geography* **42**.

Smith, D.M. (1971), *Industrial Location*, New York : Wiley.

Stevens, B.H. (1961), Linear Programming and Location Rent, *Journal of Regional Science* **3**.

Stevens, B.H. (1968), Location Theory and Programming Models : The Von Thunen Case, *(Papers and Proceedings), Regional Science Association,* Paper **11**.

Stonier, A. W. and Hague D.C.S. (1972), A Textbook of Economic Theory, London.

Strahler, A.N. (1958), Dimensional Analysis Applied to Fluvially Eroded Landforms, *Bulletin of Geological Society of America* **69**.

Thunen, J.H. Von. (1826, 1875), *Der Isolierate Staat in Beziehung Auf Landwirtschaft Und Nationalokonomie*, Hamburg.

Walker, H.M. and J. Lev (1953), *Statistical Inference*, New York : Holt, Rinehart and Winston.

Walker, I. (1967), *The European Common Market: Growth and Patterns of Trade and Development,* New York: Praeger.

Wanmali, S. and Y. Islam (1997) Rural Infrastructure and Agricultural Development in Southern Africa: A Centre-Periphery Perspective, The

Geographical Journal, Vol. **163** Part 3.

Wolpert, J. (1964), The Decision Process in Spatial Context, *Annals of the Association of American Geographers* **54**.

Yeates, M. (1974), *An Introduction to Quantitative Analysis in Human Geography*, New York : Mc Graw-Hill.

Zipf, G.K. (1949), *Human Behaviour and the Principles of Least Efforts*, Mass. : Cambridge University Press.

Lal Kitab(s), Patwari's Unpublished Records, District Gurgaon, Haryana, 1993-94.

Hydrologist, Department of Minor Irrigation, District Gurgaon, Haryana, 1993-94.

Discrict Census Handbook, District Gurgaon, Haryana, Census of India, 1991.

Agricultural statistical Bulliten, District Gurgaon, Haryana, 1992-93.

• • • • •